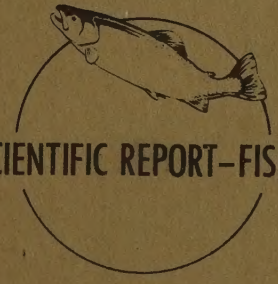
2361
257f
26

# CREEL CENSUS AND EXPENDITURE STUDY, MADISON RIVER, MONT., 1950-52

AUG 1954
LIBRARY
POFI
FISH & WILDLIFE
SERVICE



SPECIAL SCIENTIFIC REPORT–FISHERIES No. 126

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

## Explanatory Note

The series embodies results of investigations, usually of restricted scope, intended to aid or direct management or utilization practices and as guides for administrative or legislative action. It is issued in limited quantities for the official use of Federal, State or cooperating Agencies and in processed form for economy and to avoid delay in publication.

57001

Frontispiece. In addition to the fine catches of trout that can be made in stretches of water like this in the Madison Canyon, the beautiful setting contributes to the extensive use made of the Madison River. (Photo by L. E. Hiner).

United States Department of the Interior, Douglas McKay, Secretary
Fish and Wildlife Service, John L. Farley, Director

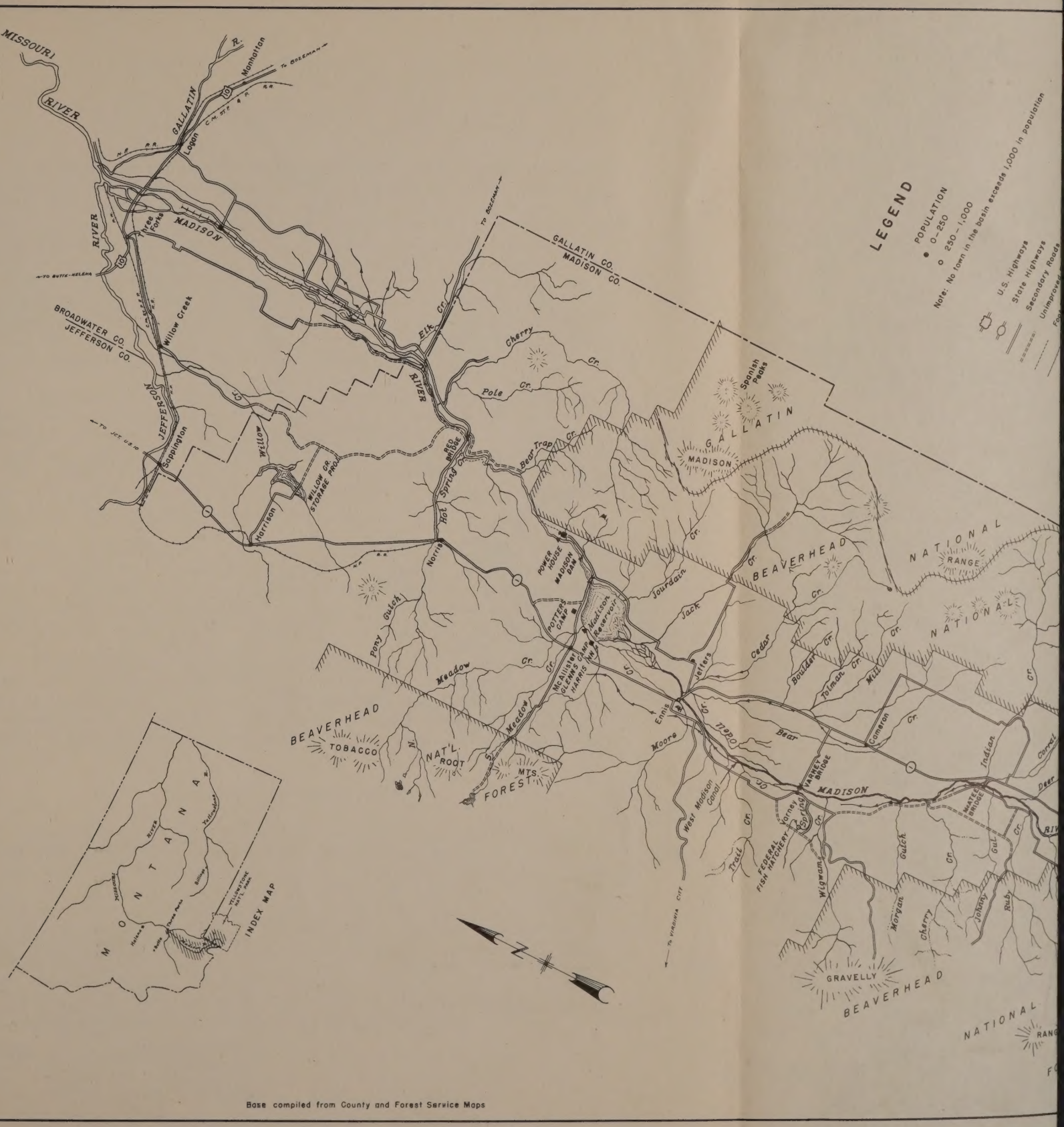
# CREEL CENSUS AND EXPENDITURE STUDY
# MADISON RIVER, MONTANA, 1950-52

Prepared in the Office of Missouri River Basin Studies
Billings, Montana

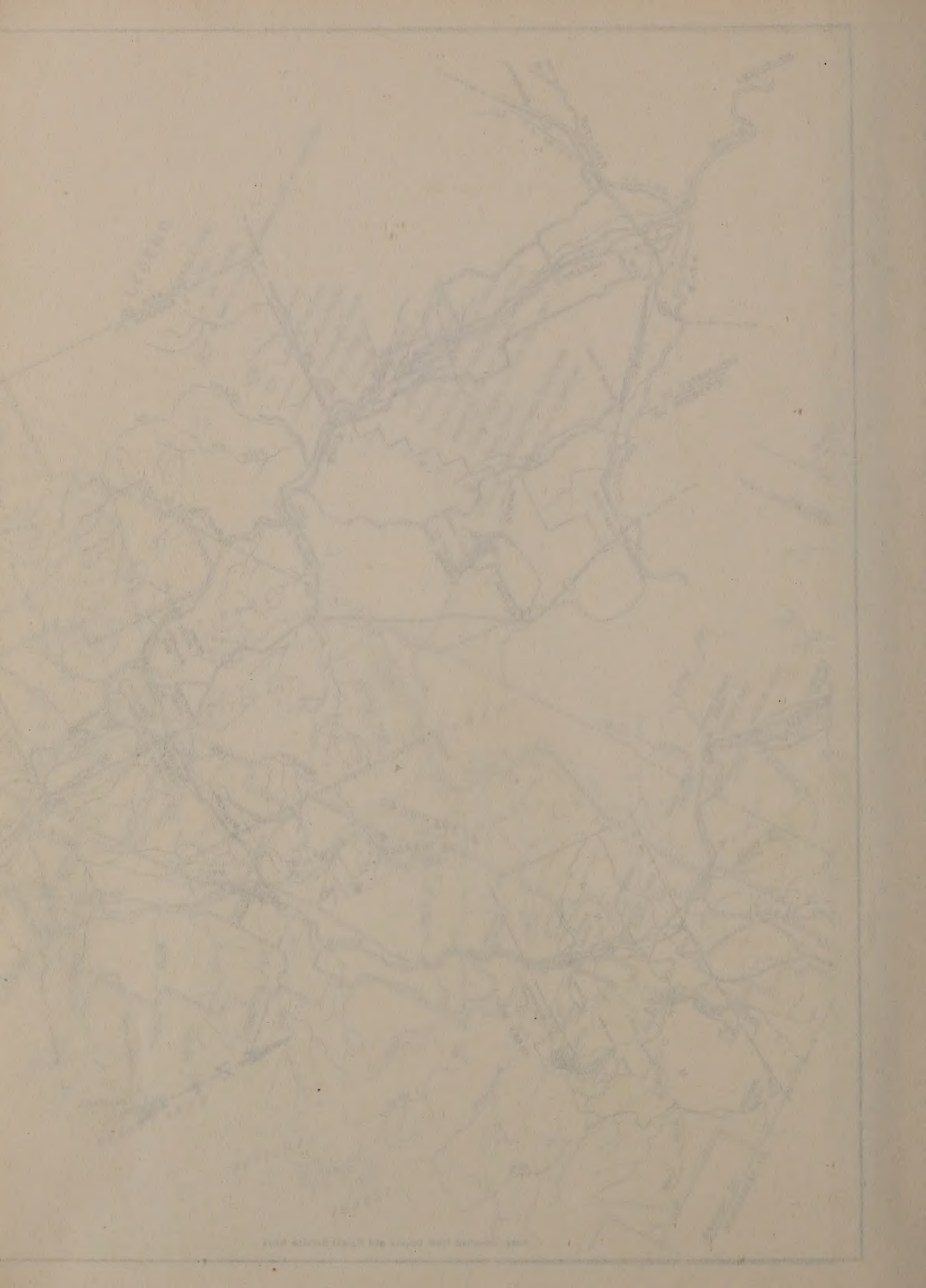
Special Scientific Report: Fisheries No. 126
Washington, D. C.
April 1954

TABLE OF CONTENTS


Introduction . . . . . 1
Location and Description . . . . . 1
Methods . . . . . 12
Results of Creel Census . . . . . 15
Fisherman-Expenditure Study . . . . . 27
    Transportation Expenditure . . . . . 27
    Trip Expenditures . . . . . 28
    Annual and Investment Expenditures . . . . . 29
    Total Expenditure . . . . . 30
Discussion . . . . . 31
Summary . . . . . 36
Literature Cited . . . . . 38




Base compiled from County and Forest Service Maps



## INTRODUCTION

A creel census and fisherman-expenditure study was conducted on the Madison River in Montana during the summers of 1950, 1951, and 1952 by Missouri River Basin Studies, Fish and Wildlife Service. The investigation was designed primarily to provide information on fishing pressure, yield, and expenditures by fishermen. Limited information was secured on some of the physical and ecological factors influencing the fishery. Information contained in this report pertains only to the regular fishing season, May through November. Although winter fishing was permitted in certain sections of the Madison for whitefish and a limited number of trout during the period of study, no investigations were conducted during the winter season.

The Madison, one of the larger mountain rivers in the Missouri River Basin, is outstanding and is famous as a trout stream. Because there are tentative plans for developing the Madison for irrigation and power, and as one of the responsibilities of Missouri River Basin Studies is determination of the effects of water-development projects on fishery resources, a detailed investigation of the present use and yield of this river appeared particularly pertinent.

The Madison River is 140 miles long. About 119 miles (in Montana and subject to development) were included in the study. It was not feasible to study the whole 119-mile stretch at one time; thus it was divided into three approximately equal sections, the lower of which was investigated in 1950, the middle one in 1951, and the upper in 1952.

Acknowledgment is made of the services and assistance rendered during the course of the study by personnel of Montana State College, especially Dr. C. J. D. Brown; Montana Fish and Game Department, especially Mr. Charles K. Phenicie; Montana Power Company; the U. S. Fish Cultural Station at Ennis; and the several resort operators in the area.

## LOCATION AND DESCRIPTION

The Madison River, located in southwestern Montana, is formed by the junction of the Firehole and Gibbon Rivers in Yellowstone National Park (see map). It flows in a general northward direction from the Park uniting with the Gallatin and Jefferson Rivers near Three Forks, Montana, to form the Missouri River. There are two on-stream reservoirs on the river: (1) Madison Reservoir, located at the head of Bear Trap Canyon, 37 river-miles above the mouth of the river; and (2) Hebgen Reservoir 1/, located at the head of Madison

---

1/ Hebgen Reservoir is also known as Hebgen Lake while Madison Reservoir is frequently called Ennis Lake or Meadow Lake.

Canyon, 101 river miles above the mouth of the river. Hebgen Reservoir backs up to the Yellowstone National Park boundary.

From the headwaters in Yellowstone Park, the Madison flows across a high plateau to Hebgen Reservoir. Downstream from Hebgen, it flows through the Madison Canyon (Frontispiece) for about 8 miles and thence into the upper Madison Valley (Figs. 1 and 2) for a distance of about 50 miles. The gradient in the upper valley averages about 29 feet per mile. The continuity of the upper Madison Valley ends abruptly at the head of Bear Trap Canyon, at the lower end of Madison Reservoir. Bear Trap Canyon (Fig. 3) is a narrow gorge about 11 miles in length. Leaving Bear Trap Canyon, the river flows for about 20 miles through the lower Madison Valley to its juncture with the Gallatin and Jefferson Rivers. The gradient of the river in the lower valley is about 16 feet per mile. The Madison drains an area of about 2,500 square miles.

Flows in the Madison River were once subject to considerable variation but now are largely controlled by operation of Hebgen and Madison Reservoirs. Normally, low flows occur in the winter and high flows in June, although, depending on weather conditions, maximum flows sometimes occur as early as March or as late as July. Normal flows during the summer period are about 2,000 second-feet. The more or less constant flows are an important factor in making the Madison River a good trout stream.

The bed of the river is composed largely of rubble and boulders (Fig. 1), however gravel or sand bars suitable for spawning sites are common. Except in the extreme lower section, the river is characterized by riffles and rapids (Fig. 3). The frequent large boulders in the channel afford cover for the fish. Many small islands in the stream between Madison Reservoir and the town of Ennis improve the habitat in this area (Fig. 2). Large pools occur in the area just above the town of Three Forks. The river varies in width from about 200 feet in Madison Canyon to about 300 feet below Madison Reservoir.

Water temperatures were taken at 8:00 a.m. daily during the period of study. In the Lower Section (1950), the average temperature was about 60° F. The recorded maximum and minimum were 70° F. and 40° F., respectively. In the Middle Section (1951), the seasonal average was 51° F. The recorded maximum was 67° F. Water temperatures exceeding 60° F. were recorded on only 6 days during the 1951 study period. In 1952, a maximum temperature of 64° F. was reached in Madison Canyon in August. The average for the period between mid-July and mid-September was about 60° F.; the seasonal average was 55° F. Twenty miles below Madison Canyon, the seasonal average temperature was about 50° F. The lower seasonal average for the area below the canyon may be attributable to inflow from numerous

Fig. 1. The Madison River below McAtee Bridge. Note the rubble in the bottom which provides cover for fish in this productive stretch of river. (Photo by L. E. Hiner).

Fig. 2. The Madison River between Ennis and Varney Bridge. Note the several channels and islands which make for a variety of habitat and considerable production. (Photo by A. J. Nicholson).

Fig. 3. A typical stretch of fast water in Bear Trap Canyon. Alternate riffles and deep holes in this stretch of the river provide conditions suitable to both rainbow and brown trout. (Photo by L. E. Hiner).

springs and seeps in that area. Temperatures cited above may be considered to be below optimum for the development of rainbow and brown trout (Needham 1938); however, growth studies of rainbow trout taken from the Madison River indicate a rate equal to or better than most Montana streams (Montana State College, unpublished data).

Chemical analysis of water from two locations in the Middle Section indicate that it is medium hard and slightly alkaline (Appendix A). Small amounts of domestic and industrial pollution occur at a few points on the river but adverse effects were not apparent. Physical pollution in the form of silt was negligible.

Most of the 102 streams tributary to the Madison (shown on the U. S. Forest Service map) are short and many are dry except during the time of snow melt. Some that are not naturally intermittent are completely dewatered during the summer by irrigators. Tributaries which are important as nursery streams include: Grayling, Duck, Cabin, Beaver, O'Dell, Jack, North Meadow, Jourdain, South Meadow, and Cherry Creeks, and the South Fork and West Fork of the Madison. These streams have minimum flows of about 25 second-feet. The West Fork of the Madison has extensive beaver dams near its mouth which prevent free movement of fish except during periods of high water.

Diversions of water from the river are common below Bear Trap Canyon; upstream from Bear Trap there are only three direct diversions. The latter are above Varney Bridge. Less than 10 second-feet is removed by the smaller of the three. The larger one, West Madison Canal, removes about 150 second-feet. A fish screen had been provided for the West Madison Canal, but it was not in operation during the period of study (1951) and a considerable number of fish went into the canal and were presumably lost. No specific investigations were conducted during this study to determine the extent of fish losses in irrigation canals arising from the Madison, but limited observations conducted on the West Madison Canal in September 1948, following an inadvertent closure, disclosed a loss of more than 14,000 trout in the first 3 miles of the canal. Total population in this 15-mile canal prior to closure was estimated to exceed 40,000 fish.

Algae and other low forms of aquatic vegetation were common in certain stretches of the river, especially in the lower reaches. Emergent aquatic vegetation was sparse. The vegetation of the valley is characteristic of the inner mountain region of the Rockies. About two-thirds of the total drainage area outside of Yellowstone National Park is included in national forests and in most areas is well timbered with conifers. In addition, many tracts of private land are covered with coniferous forests. These forests serve to protect the watershed from sudden snow melts and flash floods. Forest cover contributes to the uniform flows and thus benefits the fishery. Trees and brush on the banks of the river consist of alder, willows, and cottonwood, however much of the river bank and valley floor is free of woody vegetation.

Bottom fauna was abundant on the rubble and boulders throughout the course of the river. Nymphs of mayflies, midges, and stone flies were the most abundant forms. The largest stone fly in the United States, locally called the salmon fly (Pteronarcys californica), was abundant in most areas and was used extensively as bait.

Madison Reservoir (Fig. 4) located at the head of Bear Trap Canyon (see map), was built for power production by the Montana Power

Company in 1908. Roughly 3 miles long by 3-3/4 miles wide, it has a shoreline of 11-1/2 miles and a surface area of 3,800 acres. It has a maximum depth of 37 feet (at the dam), however it is estimated that 75 percent of the reservoir is less than 15 feet in depth. The shoreline is largely gravel. Shoal areas are extensive and appear ideal for spawning. Aquatic plant beds, including coontail, water milfoil, and pondweeds, are abundant in the upper part of the reservoir.

Fig. 4. Lower portion of Madison Reservoir. Madison Dam is located about 1-1/2 miles down Bear Trap Canyon, the head of which is evident in the background. (Photo by L. E. Hiner).

Since a relatively stable water level is maintained at Madison Reservoir by increasing or decreasing releases from Hebgen Reservoir, the use of water for generating electric power ordinarily does not affect the fishery adversely. During the summer of 1950, after several weeks of unusually dry weather, the normal level (4,541 feet m.s.l.) of the reservoir was lowered only 20 inches. On unusual occasions the water level has been lowered 8.5 feet. North Meadow Creek with a normal flow of about 25 second-feet, and Jourdain and South Meadow Creeks with somewhat smaller flows, are the only sources of water other than the Madison. All three of these creeks are important nursery streams.

Although the rate of siltation in Madison Reservoir has never been measured, it is considered to be low. Nevertheless, the water of the reservoir becomes quite turbid at times due to wave action. Surface water temperatures as recorded in 1950 ranged from 40° F. to 74° F., with an average of about 58°.

Hebgen Reservoir (see map and Fig. 5) was built in 1915, also by the Montana Power Company. Irregular in shape, it is about 18 miles long by about 2-1/2 miles wide. It has a surface area of 13,400 acres and a maximum depth of 70 feet. There are about 65 miles of shoreline.

Fig. 5. Hebgen Reservoir, surrounded by mountains and forests, is not only a beautiful spot but is productive of fish. Hebgen Dam is located around the bend to the left. (Photo by L. E. Hiner).

A number of small streams enter Hebgen Reservoir, the most important of which are the South Fork of the Madison and Duck and Grayling Creeks. These streams are used extensively by spawning fish. Other streams that may accommodate some spawning are Cherry, Rumbaugh, Watkins, and Trapper Creeks. Gravel shoal areas appear as narrow bands along the north and west shores. Although these appear to be suitable for trout spawning, their value for this is limited by fluctuations in water level.

Water ordinarily is stored in Hebgen starting immediately after the ice break-up in spring and continued through early August. Snow melt in the Madison watershed is usually more than sufficient to maintain the required volume of water for power production at Madison Reservoir during this period. Only infrequently is water released during May, June, or July. Starting in August and continuing into the fall, water releases from Hebgen are usually greater than the inflow and there is a gradual decline in the water level. It was necessary to draw most of the water out of the reservoir during the drought period of 1933 and 1934 but this was the only really unusual drawdown since creation of the reservoir. Annual drawdown is usually around 10 to 15 feet. Over the years, erratic fluctuations have been unusual and fish losses due to drawdown have been minimal.

Surface water temperatures averaged about 55° F. (12° or 15° above those in the river below the dam) in the early part of the 1952 fishing season. From the latter part of May through mid-September, temperatures usually were over 60° F. The recorded maximum was 66° F. (August).

Except for a short period when a plankton "bloom" occurred, and excepting the Grayling Arm of the reservoir, the water was clear throughout the summer of 1952. The Grayling Arm of the reservoir was extremely murky most of the time, probably because this part of the lake was a bog prior to inundation and much of the bottom material in this area is loose and exists as a false bottom, and causes roiling upon the slightest movement.

Aquatic vegetation is well established in Hebgen and bordering marshes. The shallow South Fork Arm had so many pondweeds in 1952 as to make boating impractical. Pondweeds also were abundant in the Madison Arm. Timber was not cleared from Hebgen when it was created, and a considerable stretch along the west shore of the Madison Arm now has submerged logs which make fishing, especially trolling, difficult.

No bottom fauna studies were made in Hebgen, but general observations indicated an abundance of stone fly nymphs, mayfly nymphs, and dipterous larvae, especially in the weedy areas of the lake.

Climatic conditions in the Madison Basin are characteristic of the northern Rocky Mountain Region. Owing to the mountainous nature of the basin (elevations varying from 4,000 to 11,000 feet), climatic conditions vary widely at different points. The winters are generally severe, with many days of subzero temperature. January temperatures average between 10 and 20° F. The days are generally clear and warm and the nights cool in the summer. Mid-summer temperatures average 65° F. The growing season is relatively short, ranging

from 88 days at Hebgen Dam to 112 days at Three Forks. The average annual precipitation at Ennis is 10.69 inches. Ordinarily about 59 percent of the total precipitation for the season falls between May and September. Snow may fall as late as mid-June or as early as Labor Day.

The rapid rate of flow of the Madison River and the warming effect of seepage and springs generally prevents solid ice from forming on the river. Such ice as does form is usually in the form of frazil ice and usually occurs in the area just above Madison Reservoir. During extreme winters, ice may jam-up in the area above Madison Reservoir and causes flooding of the floodplains as far upstream as 25 miles. Effects of ice formation were not studied during this investigation, but some damage to the fishery undoubtedly occurs when ice forces the river out of its banks and onto the floodplain.

Southwestern Montana is sparsely populated. For instance, Madison County, which straddles the Madison River throughout most of its length, has a population of only 5,998 or 1.7 people per square mile. There are only six towns in the Madison Valley; namely: Three Forks, Norris, McAllister, Ennis, Jeffers, and West Yellowstone. These are all relatively small, having a combined permanent population of about 2,000 people. The population of most of these towns is materially increased by temporary residents during the summer. This is especially true of West Yellowstone where the temporary population may increase to as many as 2,000 people, a tenfold increase over the winter population.

The economy of the Madison Basin is based upon livestock grazing, and, particularly in the lower valley, wheat farming. Trade from fishermen and tourists is an important source of revenue to residents of the valley during the summer. Winter and summer range for elk, deer, and moose is extensive and big-game hunting also is important to the economy. Prior to World War II, gold mining was an active industry; but most of the mines have now been closed and some 2,000 miners and their families, who formerly represented a large part of the local population, have moved away.

The Madison River can be reached at Three Forks by east-west U. S. Highway 10, at Norris by a good gravel road between Bozeman and Norris, and at West Yellowstone by north-south U. S. Highway 191. State Highway 1 parallels the river from McAllister (near Madison Reservoir) upstream to West Yellowstone. Several trails and county roads branch off this highway to the river. A county road closely parallels the north and east shores of Madison Reservoir. Hebgen Reservoir is nearly encircled by trails. About the only sections not readily accessible by car are Bear Trap Canyon and the lower 15 miles of the river. As a general rule, the latter area can be reached only by going through private property, much of which is posted against trespass. Eating and sleeping facilities are available in most of the towns, and several

resorts on Madison and Hebgen Reservoirs provide boats and dock facilities. There are several ranches, mostly above Ennis, which take in guests or have tourist cabins. The Forest Service maintains a number of campgrounds in Madison Canyon and around Hebgen Reservoir. There were 76 private summer homes on Hebgen Reservoir in 1952.

Eight species of fish were recorded from fishermen's creels during the course of the study; these included: rainbow trout, brown trout, brook trout, cutthroat trout, grayling, mountain whitefish, suckers, and Utah chub. Brook trout and grayling were not recorded from Hebgen Reservoir but were undoubtedly there. Only a few Utah chubs were taken from the river. A number of apparent hybrid trout (rainbow x cutthroat, and in one instance an apparent rainbow - brown[2/]) were noted during the course of the study. Because hybrids could not always be ascertained accurately, and because the characteristics of most apparent hybrids were predominantly rainbow, all apparent hybrids were classified as rainbows for the purpose of this report.

As might be suspected the species composition of the Madison has not always been as indicated above. Prior to 1900, the association apparently was one of whitefish, grayling, a few cutthroat trout, and suckers. Commercial fishermen who operated around the turn of the century indicated that 2½-pound, 20-inch whitefish were common then. Grayling varied from 8 to 15 inches in length.

The first introductions of fish into the Madison were of steelhead trout-shortly after 1900. Brown trout were first introduced about 1910 and have increased in numbers each year since then. Grayling and whitefish populations seemed to decline as brown trout increased. Most of the grayling population was gone by 1920, but whitefish continued to persist in fair numbers. Suckers and brown trout were gradually replacing the grayling-whitefish association until rainbow and brook trout were introduced around 1920; rainbows have since become the dominant species.

Hebgen Reservoir was heavily stocked with rainbow and brown trout upon its completion in 1915. These two species dominated the Hebgen fishery in about three years, replacing the whitefish-grayling association which persisted until that time.

The Utah chub, foreign to the Missouri River drainage and considered a nuisance by most fishermen, was first taken in Hebgen Reservoir in the mid-30's. It was probably introduced by live-bait fishermen. Apparently it has steadily increased in numbers since its introduction. Gill-net studies in 1948 and 1949 (Hays 1950)

---

2/ Apparent rainbow x brown specimens in collection of Montana State College, Bozeman, Montana.

indicated a ratio of six chubs to one trout in shallow water and two to one in deeper water. While studies made by Hays indicate no significant competition for food between trout and chubs, chubs certainly compete with trout for space.

Recent management of the Madison River fishery has consisted of stocking and enforcement of fishing regulations.

Legal-sized fish, mostly rainbow and brown trout, have been stocked almost exclusively during the past 10 years. Most of these fish have been provided by the U. S. Fish Cultural Station located near Ennis, with some being supplied by the U. S. Fish Cultural Station at Bozeman.

State fishing regulations in force during the study specified a creel limit of 15 fish, including not more than 5 fish under 7 inches in length, or 10 pounds and 1 fish for the river and Madison Reservoir. The creel limit on Hebgen Reservoir was 5 fish not to exceed 10 pounds and 1 fish. Seasons are shown in Table 1 by year and area affected.

Table 1. Number of Days and Season Dates of the Regular Fishing Season, Madison River, Montana, 1950, 1951, and 1952

| Year | Area | Days in Season | Season Dates |
|---|---|---|---|
| 1950 | Madison River -- Below Madison Reservoir | 147 | May 21 to October 14, inclusive |
| | Madison Reservoir | 179 | May 21 to November 15, inclusive |
| | Madison River -- Between Madison Reservoir and Ennis | 147 | May 21 to October 14, inclusive |
| 1951 | Madison River -- Between Madison Reservoir and Ennis | 153 | June 16 to November 15, inclusive |
| | Madison River -- Between Ennis and upper end of Study Area | 134 | May 20 to September 30, inclusive |
| 1952 | Madison River -- Entire study area including Hebgen Reservoir | 136 | May 18 to September 30, inclusive |

## METHODS

As already indicated, 119 miles of the Madison River (from its mouth to the head of Hebgen Reservoir) was included in the study. To facilitate the investigation, this portion of the river was divided into three sections, each of which was studied one season. Each of the major sections was further divided into check areas, not only to facilitate the study but to enable the investigators to differentiate between usage, yield, and other aspects of the fishery. Limits of each section or check area were selected at points which permitted the least opportunity for fishermen to move from one to the other. The three sections and the various check areas are shown diagramatically in Figure 6.

Intensive operations were begun with the opening of the fishing season and continued through September 30 each year. In addition, in 1950 a 7-day check was made of both the Lower Section and Madison Reservoir in mid-October and a 4-day check was made of Madison Reservoir in mid-November. A 4-day check of the Channel Area was made in mid-October in 1951. Except for the fall checks when only one man was used, crews of five to seven men were available for conducting the study.

Data were obtained for each check area by means of patrols or check stations, check stations being used whenever possible. It was not always practical to conduct daily, full-day censuses of all check areas within a section; and in such instances, a schedule was arranged for coverage on alternate mornings and afternoons. Coverage was always made on Saturdays, Sundays, and holidays. Each crew member's two nonwork days were taken during the week and these were alternated so that all weekdays were covered over a 2-week period. Every effort was made to contact as many fishermen as possible. Conditions were such on the Madison River that uncontacted parties usually could be accounted for and recorded; thus, knowledge was had of the total number of fishermen using a check area during any check period. The percent of the parties which were contacted was: 1950, river, 54 percent, and Madison Reservoir, 49 percent; 1951, river, 69 percent; and 1952, river, 48 percent, and Hebgen Reservoir, 21 percent.

Exception to the general plan of operation outlined above was made for the Three Forks Check Area because prestudy observations indicated that it received limited use by fishermen. A total of 15 patrols of one day each was made of this area. These checks were scheduled so that five Saturdays, five Sundays, and one each of the weekdays were represented.

Data secured from contacted fishermen relative to use and yield of the fisheries included the number of fishermen per party, home address, type of fishing (boat or shore), time spent fishing,

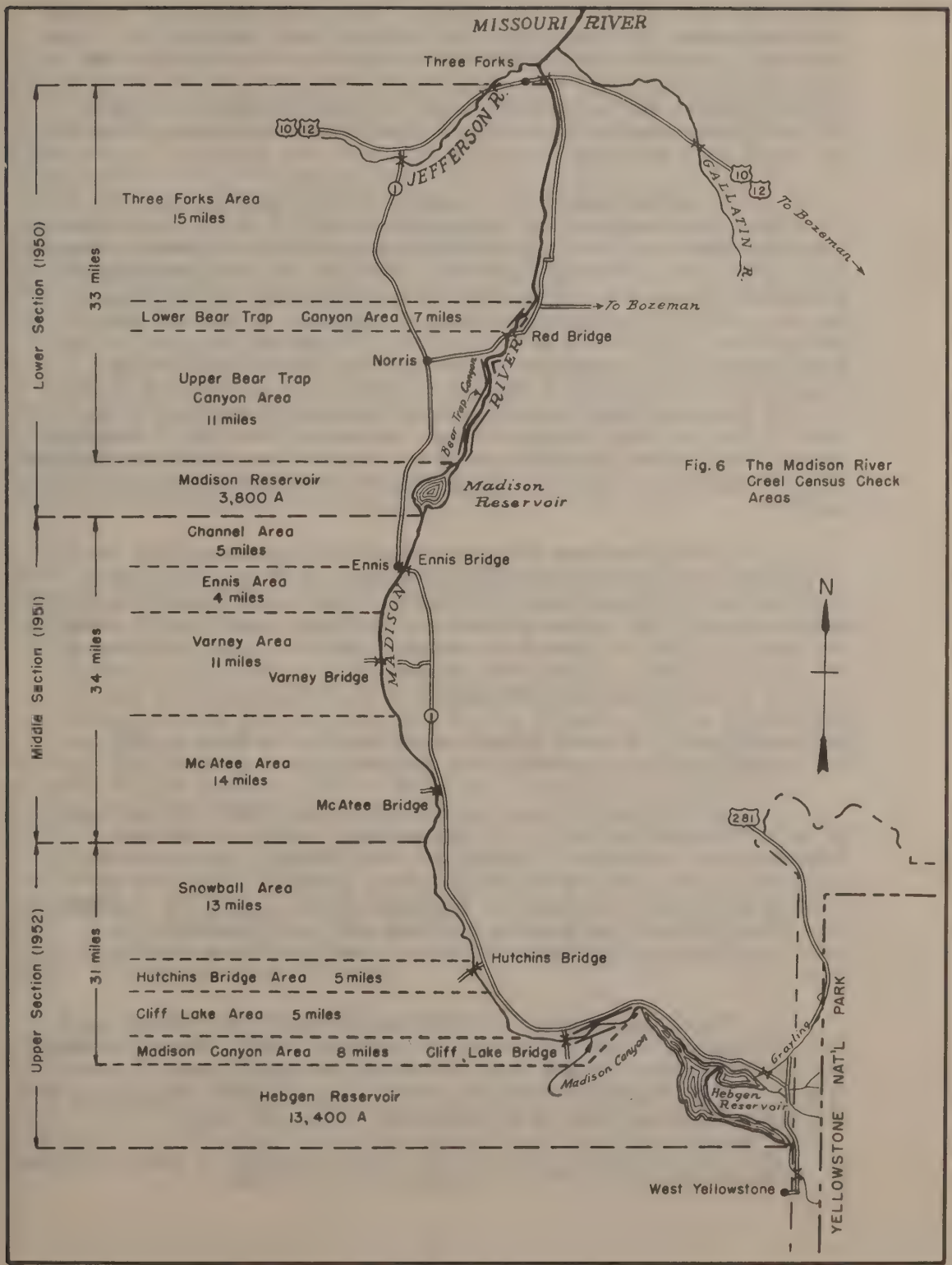



Fig. 6 The Madison River Creel Census Check Areas

and number and species of fish caught. Data ordinarily were secured from one member of the party. Data obtained were compiled for 2-week periods[3/] and applied to fishermen observed but not contacted and those known to be present on check days in the same period of time. Total estimates of fisherman-day use and yield in numbers of fish for each check area were based on a summation of estimates obtained for the 2-week periods.

An attempt was made to secure weights and measurements of a nonselective sample of the various species of fish from each check area, but this was not always possible because most fishermen cleaned their fish before leaving the water. Further, so few specimens of some species were taken that adequate samples could not be secured for an individual check area or even a section. In view of these difficulties, these data were combined, by species, for each of the three sections of stream and the two reservoirs, and the average weights thus obtained were applied to the estimated yield in numbers of fish from each check area within the respective sections to determine the yield in pounds of fish. Because of lack of an adequate sample, average weights obtained in one section were sometimes applied in other sections. In a few instances, the average weight was estimated.

A short section of stream immediately above Madison Reservoir (lower section of Channel Check Area) can be reached readily only by boat. Although use of boats for fishing was prohibited on this section of the river, a number of fishermen used them to reach the area from Madison Reservoir and then walked a short distance up the river to fish. It was most convenient to check these fishermen in 1950 in connection with the census of Madison Reservoir; and for the purpose of this report, it has been assumed that the estimated use in 1950 and the yield therefrom was similar to that in 1951 and was in addition to other estimates secured for the area in 1951.

Definition of terms used in this report are: party, one or more fishermen who made a trip together, usually in one car; fisherman-day, one day of fishing by an individual fisherman irrespective of the number of hours involved; pole-hour, one hour of fishing effort by an individual fisherman (synonymous with fisherman-hour since Montana law permits only one pole per fisherman); and rate of catch, average number of fish or pounds of fish caught per pole-hour.

Fisherman-expenditure data were obtained on a party basis from virtually all parties contacted for creel data. These included the point of origin of the trip (for miles traveled); days in the trip; and expenditures per day for food, lodging, bait, rentals, and miscellaneous items such as refreshments, film, and ice.

---

3/ Compilations were made on a weekly basis in 1950.

The average round-trip mileage per person per day was determined by dividing the total number of miles in the round trip (from the point of origin of the trip to the point of contact) by the number of fishermen in the party and the number of days in the fishing trip. A rate of 7 cents per mile was used to determine transportation costs. Occasionally fishermen were visiting nearby or were on a business trip; thus, use of mileage from the point of origin of the particular trip to the point of contact should more nearly approximate the mileage actually traveled on the fishing trip. Extra miles which might have been driven during the course of a fishing trip were disregarded as there was no adequate way of determining the exact extent of extra driving. Trip expenditures were converted to the average per person per day by dividing by the number of people in the party.

It is recognized that there were differences in the average round-trip mileage and trip expenditures for the various check areas, but an average daily expenditure figure (weighted by the number of individuals in each yearly sample) was derived for each section. These figures were then applied to estimates of the number of fisherman-days and yield for the respective sections of river and the two reservoirs for derivation of total expenditures.

In some instances complete data could not be obtained on all aspects of the study, thus those interview records were left out for purposes of calculating the particular aspects for which data were incomplete. Accordingly, the number of individuals in the various samples listed in tables is not always the same.

## RESULTS OF CREEL CENSUS

Based on data shown in Tables 2, 3, 4, and 5, using prescribed methods, and assuming that there was no difference in the relative use or yield of the various sections from year to year, it is estimated that approximately 40,772 fisherman-days were expended annually on the river as a whole over the 3-year period 1950 to 1952 (Table 6). The annual yield was about 80,459 fish weighing 82,682 pounds. Separated into the component fisheries, i.e., stream or reservoir, annual fishing pressure and yield for the 98 miles of stream was estimated to be about 22,660 fisherman-days and 52,424 fish weighing 48,385 pounds, while that for the two reservoirs was about 18,112 fisherman-days and 28,035 fish weighing 34,297 pounds.

Considering the 98 miles of stream, fishing pressure and yield per mile was about 231 fisherman-days and 535 fish weighing 494 pounds (Table 7). It will be noted from Table 7 that there was considerable variation in the pressure and yield from check area to check area, although that for each of the three sections was remarkably similar. The greater rate of use of Lower Bear Trap Canyon, Channel, Ennis, and Madison Canyon Areas probably can be attributed

Table 2. Recorded Fishing Parties and Fishermen, and Average Number of Fishermen per Party, by Check Area and Check Periods, Madison River, Montana, 1950, 1951, 1952

| Year | Section | Fishery | Check Area | Check Period 1/ | Fishermen Contacted: Parties | Fishermen Contacted: Fishermen | Fishermen per Party |
|---|---|---|---|---|---|---|---|
| 1950 | Lower | Stream | Three Forks 2/ | 1 | 0 | 0 | -- |
| | | | | 2 | 0 | 0 | -- |
| | | | Subtotal | | 0 | 0 | -- |
| | | | Lower Bear Trap Canyon | 1 | 620 | 1,485 | 2.40 |
| | | | | 2 | 14 | 30 | 2.14 |
| | | | Subtotal | | 634 | 1,515 | 2.39 |
| | | | Upper Bear Trap Canyon | 1 | 1,058 | 2,593 | 2.45 |
| | | | | 2 | 45 | 81 | 1.08 |
| | | | Subtotal | | 1,103 | 2,674 | 2.42 |
| | | | Total | | 1,737 | 4,189 | 2.41 |
| | | Reservoir | Madison Reservoir | 1 | 1,459 | 3,669 | 2.51 |
| | | | | 2 | 26 | 54 | 2.08 |
| | | | | 3 | 13 | 25 | 1.92 |
| | | | Total | | 1,498 | 3,748 | 2.50 |
| 1951 | Middle | Stream | Channel | 1 | 219 | 582 | 2.66 |
| | | | | 2 | 348 | 803 | 2.31 |
| | | | | 3 | 0 | 0 | -- |
| | | | Subtotal | | 567 | 1,385 | 2.44 |
| | | | Ennis | 4 | 353 | 736 | 2.08 |
| | | | Varney | 4 | 246 | 560 | 2.28 |
| | | | McAtee | 4 | 264 | 596 | 2.26 |
| | | | Total | | 1,430 | 3,277 | 2.29 |
| 1952 | Upper | Stream | Snowball | 1 | 189 | 389 | 2.06 |
| | | | Hutchins Ranch | 1 | 227 | 459 | 2.02 |
| | | | Cliff Lake | 1 | 233 | 547 | 2.35 |
| | | | Madison Canyon | 1 | 607 | 1,282 | 2.11 |
| | | | Total | | 1,256 | 2,677 | 2.13 |
| | | Reservoir | Hebgen Reservoir | | | | |
| | | | Shore fishermen | 1 | 204 | 481 | 2.36 |
| | | | Boat fishermen 3/ | 1 | 590 | 1,621 | 2.75 |
| | | | Total | | 794 | 2,102 | 2.65 |

1/ Check periods:
1950: 1. May 21 through September 30.
2. October 8 through October 14
3. November 2 through November 5
1951: 1. May 21 through September 30, 1950-see parg. 3, page 11.
2. June 16 through September 30, 1951.
3. November 1 through November 4, 1951.
4. May 20 through September 30, 1951.
1952: 1. May 18 through September 30.

2/ Only 9 fishing parties were observed during 15 patrols; no one was contacted.

3/ Data secured from the operator of one resort.

Table 3. Recorded Pole-hours and Fish Caught, and the Rate of Catch, by Check Areas and Check Periods, Madison River, Montana, 1950, 1951, 1952

| Year | Section | Fishery | Check Area | Check Period 1/ | Recorded | | Average Rate of Catch | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Pole-hours | Fish | Fish/Hour | Pounds/ Hour |
| 1950 | Lower | Stream | Three Forks 1/ | 1 | 0 | 0 | -- | -- |
| | | | | 2 | 0 | 0 | -- | -- |
| | | | Subtotal | | 0 | 0 | -- | -- |
| | | | Lower Bear Trap Canyon | 1 | 6,019 | 2,205 | 0.37 | 0.42 |
| | | | | 2 | 125 | 45 | 0.36 | 0.45 |
| | | | Subtotal | | 6,144 | 2,250 | 0.37 | 0.42 |
| | | | Upper Bear Trap Canyon | 1 | 14,822 | 6,703 | 0.45 | 0.45 |
| | | | | 2 | 346 | 167 | 0.48 | 0.56 |
| | | | Subtotal | | 15,168 | 6,870 | 0.45 | 0.45 |
| | | | Total | | 21,312 | 9,120 | 0.43 | 0.44 |
| | | Reservoirs | Madison Reservoir | 1 | 19,666 | 6,230 | 0.32 | 0.39 |
| | | | | 2 | 275 | 90 | 0.33 | 0.40 |
| | | | | 3 | 133 | 61 | 0.46 | 0.54 |
| | | | Total | | 20,074 | 6,381 | 0.32 | 0.39 |
| 1951 | Middle | Stream | Channel | 1 | 3,341 | 1,803 | 0.54 | 0.44 |
| | | | | 2 | 3,535 | 2,638 | 0.75 | 0.64 |
| | | | | 3 | 0 | 0 | -- | -- |
| | | | Subtotal | | 6,876 | 4,441 | 0.65 | 0.54 |
| | | | Ennis | 4 | 2,781 | 1,767 | 0.64 | 0.58 |
| | | | Varney | 4 | 2,612 | 1,461 | 0.56 | 0.51 |
| | | | McAtee | 4 | 2,268 | 1,281 | 0.56 | 0.55 |
| | | | Total | | 14,537 | 8,950 | 0.62 | 0.54 |
| 1952 | Upper | Stream | Snowball | 1 | 1,320 | 1,082 | 0.82 | 0.67 |
| | | | Hutchins Ranch | 1 | 1,491 | 773 | 0.52 | 0.43 |
| | | | Cliff Lake | 1 | 1,954 | 1,181 | 0.60 | 0.54 |
| | | | Madison Canyon | 1 | 4,119 | 1,865 | 0.45 | 0.38 |
| | | | Total | | 8,884 | 4,901 | 0.55 | 0.47 |
| | | Reservoirs | Hebgen Reservoir | | | | | |
| | | | Shore fishermen | 1 | 1,530 | 553 | 0.36 | 0.42 |
| | | | Boat fishermen 3/ | 1 | 7,295 | 2,125 | 0.29 | 0.36 |
| | | | Total | | 8,825 | 2,678 | 0.30 | 0.37 |
| Total for stream | | | | | 44,733 | 22,971 | 0.51 | 0.48 |
| Total for reservoirs | | | | | 28,899 | 9,059 | 0.31 | 0.38 |

1/, 2/, 3/ See footnotes 1, 2, and 3, respectively, Table 2.

Table 4. Number and Percent of Fish in Fisherman's Creels, by Species, Madison River, Montana, 1950, 1951, and 1952

| Year | Section | Fishery | Check Area | Rainbow Trout | | Brown Trout | | Brook Trout | | Cutthroat Trout | | Whitefish | | Suckers | | Utah Chub | | Grayling | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| 1950 | Lower | Stream | Three Forks 1/ | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - | 0 | - |
| | | | Lower Bear Trap Canyon | 740 | 32.9 | 877 | 39.0 | 18 | 0.8 | 0 | - | 536 | 23.8 | 79 | 3.5 | 0 | - | 0 | - |
| | | | Upper Bear Trap Canyon | 4,302 | 62.6 | 1,793 | 26.1 | 1 | 2/ | 4 | 0.1 | 548 | 8.0 | 202 | 2.9 | 0 | - | 20 | 0.3 |
| | | | Total | 5,042 | 55.3 | 2,670 | 29.3 | 19 | 0.2 | 4 | 0.1 | 1,084 | 11.9 | 281 | 3.1 | 0 | - | 20 | 0.2 |
| | | Reservoir | Madison Reservoir | 4,543 | 71.2 | 1,055 | 16.5 | 9 | 0.1 | 10 | 0.2 | 5 | 0.1 | 702 | 11.0 | 5 | 0.1 | 52 | 0.8 |
| 1951 | Middle | Stream | Channels 3/ | 3,304 | 74.4 | 658 | 14.8 | 8 | 0.1 | 0 | - | 42 | 0.9 | 372 | 8.4 | 0 | - | 57 | 1.4 |
| | | | Ennis | 1,131 | 64.0 | 473 | 26.7 | 5 | 0.3 | 1 | 0.1 | 126 | 7.1 | 26 | 1.5 | 0 | - | 5 | 0.3 |
| | | | Varney | 907 | 62.2 | 430 | 29.4 | 5 | 0.3 | 0 | - | 61 | 4.2 | 53 | 3.6 | 0 | - | 5 | 0.4 |
| | | | McAtee | 683 | 53.3 | 247 | 19.3 | 2 | 0.1 | 0 | - | 336 | 26.2 | 8 | 0.7 | 0 | - | 5 | 0.4 |
| | | | Total | 6,025 | 67.3 | 1,808 | 20.2 | 20 | 0.2 | 1 | 2/ | 565 | 6.3 | 459 | 5.2 | 0 | - | 72 | 0.8 |
| 1952 | Upper | Stream | Snowball | 786 | 72.6 | 97 | 9.0 | 1 | 0.1 | 3 | 0.3 | 174 | 16.1 | 10 | 0.9 | 5 | 0.5 | 6 | 0.5 |
| | | | Hutchins Ranch | 574 | 74.3 | 132 | 17.1 | 0 | - | 4 | 0.5 | 63 | 8.1 | 0 | - | 0 | - | 0 | - |
| | | | Cliff Lake | 879 | 74.4 | 229 | 19.4 | 2 | 0.2 | 4 | 0.3 | 67 | 5.7 | 0 | - | 0 | - | 0 | - |
| | | | Madison Canyon | 1,345 | 72.1 | 359 | 19.2 | 1 | 2/ | 3 | 0.2 | 152 | 8.2 | 3 | 0.2 | 2 | 0.1 | 0 | - |
| | | | Total | 3,584 | 73.1 | 817 | 16.7 | 4 | 0.1 | 14 | 0.3 | 456 | 9.3 | 13 | 0.3 | 7 | 0.1 | 6 | 0.1 |
| | | Reservoir | Hebgen Reservoir | | | | | | | | | | | | | | | | |
| | | | Shore fishing | 262 | 47.4 | 160 | 28.9 | 0 | - | 7 | 1.3 | 4 | 0.7 | 2 | 0.4 | 118 | 21.3 | 0 | - |
| | | | Boat fishing | 1,490 | 70.1 | 556 | 26.2 | 0 | - | 18 | 0.9 | 4 | 0.2 | 0 | - | 57 | 2.7 | 0 | - |
| | | | Total | 1,752 | 65.4 | 716 | 26.7 | 0 | - | 25 | 0.9 | 8 | 0.3 | 2 | 0.1 | 175 | 6.6 | 0 | - |

1/ See footnote 1, Table 2.
2/ Less than 0.1 percent.
3/ Fish recorded in both 1950 and 1951 combined. See paragraph 3, page 14.

Table 5. Average Weights and Lengths of Fish from Fisherman's Creels, Madison River, Montana, 1950, 1951, 1952

| Fishery | Check Area | Rainbow Trout | | | Brown Trout | | | Brook Trout | | | Cutthroat Trout 1/ | | | Whitefish | | | Grayling | | | Utah Chub | | | Suckers | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. in Sample | Avg. Wt. | Avg. Lgth. | No. in Sample | Avg. Wt. | Avg. Lgth. | No. in Sample | Avg. Wt. | Avg. Lgth. | No. in Sample | Avg. Wt. | Avg. Lgth. | No. in Sample | Avg. Wt. | Avg. Lgth. | No. in Sample | Avg. Wt. | Avg. Lgth. | No. in Sample | Avg. Wt. | Avg. Lgth. | No. in Sample | Avg. Wt. | Avg. Lgth. |
| Stream Section | Lower, 1950 | 279 | 0.79 | 12.1 | 276 | 1.46 | 14.8 | | 0.50 | 13.0 | 0 | 0.79 | | 79 | 1.03 | 14.6 | | 0.81 | 12.1 | | | | | 1.15 | 12.9 |
| | Middle, 1951 | 333 | 0.72 | 11.8 | 123 | 1.24 | 14.2 | | 0.50 | 13.0 | 0 | 0.72 | | 29 | 1.29 | 15.8 | 2/14 | 0.81 | 12.1 | | | | | 1.15 | 12.9 |
| | Upper, 1950 | 142 | 0.61 | 11.3 | 47 | 1.50 | 14.4 | 2/1 | 0.50 | 13.0 | 0 | 0.61 | | 26 | 1.35 | 16.1 | | 0.81 | 12.1 | | 0.75 | 12.1 | 2/19 | 1.15 | 12.9 |
| Reservoir | Madison, 1950 | 135 | 1.22 | 15.2 | 66 | 1.29 | 15.6 | | 0.50 | 13.0 | 0 | 1.22 | | 3/ | 1.29 | | | 0.81 | 12.1 | 2/2 | 0.75 | 12.1 | | 1.15 | 12.9 |
| | Hebgen, 1952 | 12 | 1.17 | 15.6 | 20 | 1.46 | 15.6 | | | | 0 | 1.17 | | 4/ | 1.35 | | | | | | 0.75 | 12.1 | | 1.15 | 12.9 |

1/ No cutthroat trout were weighed or measured but the few that were taken were judged to be similar in size to the rainbows taken from each section.
2/ Because of the limited sample, all specimens combined and the average weight thus obtained applied to all sections.
3/ Estimate based on proximity of reservoir to Middle Section.
4/ Estimate based on proximity of reservoir to Upper Section.

Table 6. Estimated Fishing Pressure and Yield, by Check Areas, Madison River, Montana, 1950, 1951, and 1952

| Year | Section | Fishery | Check Area | Total Fishing | | Total Yield | |
|---|---|---|---|---|---|---|---|
| | | | | Fisherman-days | Pole-hours | Number of Fish | Pounds of Fish |
| 1950 | Lower | Stream | Three Forks | 220 | 990 | 375 | 400 |
| | | | Lower Bear Trap Canyon | 2,913 | 13,177 | 5,067 | 5,668 |
| | | | Upper Bear Trap Canyon | 4,974 | 28,530 | 13,356 | 13,284 |
| | | | Subtotal | 8,107 | 42,697 | 18,798 | 19,352 |
| | | Reservoir | Madison Reservoir | 7,972 | 44,347 | 14,797 | 18,144 |
| | | | Total | 16,079 | 87,044 | 33,595 | 37,496 |
| 1951 | Middle | Stream | Channel | 2,695 | 13,892 | 8,862 | 7,437 |
| | | | Ennis | 1,774 | 6,474 | 3,761 | 3,405 |
| | | | Varney | 1,211 | 5,664 | 3,121 | 2,846 |
| | | | McAtee | 1,627 | 5,980 | 3,547 | 3,451 |
| | | | Total | 7,307 | 32,010 | 19,291 | 17,139 |
| 1952 | Upper | Stream | Snowball | 1,015 | 3,520 | 2,681 | 2,187 |
| | | | Hutchins Bridge | 1,152 | 4,301 | 2,264 | 1,861 |
| | | | Cliff Lake | 1,509 | 6,029 | 3,771 | 3,110 |
| | | | Madison Canyon | 3,570 | 12,429 | 5,619 | 4,736 |
| | | | Subtotal | 7,246 | 26,279 | 14,335 | 11,894 |
| | | Reservoir | Hebgen Reservoir | 10,140 | 43,705 | 13,238 | 16,153 |
| | | | Total | 17,386 | 69,984 | 27,573 | 28,047 |
| Total for stream | | | | 22,660 | 100,986 | 52,424 | 48,385 |
| Total for reservoirs | | | | 18,112 | 88,052 | 28,035 | 34,297 |
| Grand Total | | | | 40,772 | 189,038 | 80,459 | 82,682 |

Table 7. Estimated Fishing Pressure and Yield per Mile of Stream or Surface Acre of Reservoirs by Check Area, Madison River, Montana, 1950, 1951, and 1952

| Year | Section | Fishery | Check Area | Size of Area (Miles of Stream or Surface Acres of Reservoir) | Per Mile of Stream or Surface Acre of Reservoir | | |
|---|---|---|---|---|---|---|---|
| | | | | | Fishing Pressure | Yield | |
| | | | | | Fisherman-days | Numbers of Fish | Pounds of Fish |
| 1950 | Lower | Stream | Three Forks | 15 | 14.7 | 25.0 | 26.7 |
| | | | Lower Bear Trap Canyon | 7 | 416.1 | 723.9 | 809.7 |
| | | | Upper Bear Trap Canyon | 11 | 452.2 | 1,214.2 | 1,207.6 |
| | | | Subtotal | 33 | 245.7 | 569.6 | 586.4 |
| | | Reservoir | Madison Reservoir | 3,800 | 2.1 | 3.9 | 4.8 |
| 1951 | Middle | Stream | Channel | 5 | 539.0 | 1,772.4 | 1,487.4 |
| | | | Ennis | 4 | 443.5 | 940.3 | 851.3 |
| | | | Varney | 11 | 110.1 | 283.7 | 258.7 |
| | | | McAtee | 14 | 116.2 | 253.4 | 246.5 |
| | | | Total | 34 | 214.9 | 567.4 | 504.1 |
| 1952 | Upper | Stream | Snowball | 13 | 78.1 | 206.2 | 168.2 |
| | | | Hutchins Ranch | 5 | 230.4 | 452.8 | 372.2 |
| | | | Cliff Lake | 5 | 301.8 | 754.2 | 622.0 |
| | | | Madison Canyon | 8 | 446.3 | 702.4 | 592.0 |
| | | | Subtotal | 31 | 233.7 | 462.4 | 383.7 |
| | | Reservoir | Hebgen Reservoir | 13,400 | 0.8 | 1.0 | 1.2 |
| Total for stream | | | | 98 | 231.2 | 534.9 | 493.8 |
| Total for reservoirs | | | | 17,200 | 1.1 | 1.6 | 2.0 |

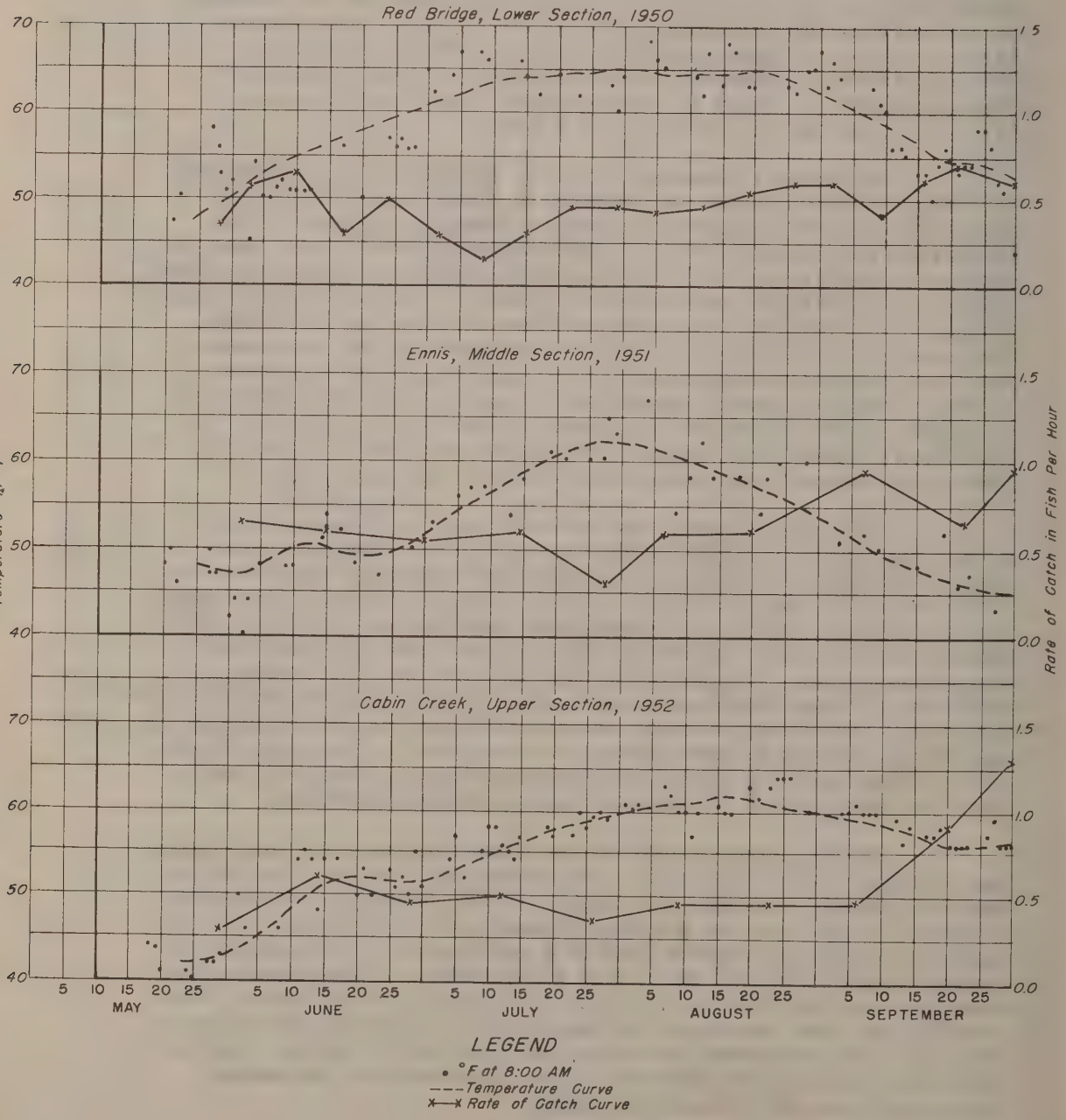
to ease of access as roads were adjacent to all these areas. The Three Forks, Varney, McAtee, and Snowball Areas were generally accessible by car at only one or two points, thus necessitating some walking to cover any appreciable amount of water. All these areas also were extensively posted against trespass, which undoubtedly was a factor in the lower use ascribed to them. The comparatively high use of Upper Bear Trap Canyon must be attributable to its reputation for being productive in terms of both numbers of fish and pounds of fish, as access, other than by walking, was limited to the two extremities of the area.

According to Rounsefel (1946), lakes the size of Madison and Hebgen Reservoirs can be expected to yield about 3.6 and 2.2 pounds per surface acre, respectively. Actually the yield from Hebgen was only about 1/2 (1.2 pounds) that expected, while that for Madison Reservoir was 1-1/3 (4.8 pounds) times greater than expected (Table 7). Since the rate of catch (Table 3) and the average weight (Table 5) of fish taken was quite similar for the two reservoirs, the pressure per surface acre might be expected to be at variance with the expected to approximately the same degree as the yield. Although proportionately greater use of Madison Reservoir over that of Hebgen (Table 7) was to be expected under these conditions, the fact that Madison was closest to centers of resident population (Butte and Bozeman) may have contributed to its greater use.

As a general rule, the rate of catch in fish per hour of effort was greatest in the Middle Section of the river while the rate in the Upper Section was somewhat better than in the Lower Section (Table 3). Except for the Channel Area, the better rates seem to be correlated with less fishing pressure (Tables 3 and 7). The Channel Area did not conform to this general rule as it had one of the highest rates of catch (0.75 fish per hour in 1951 - Table 3) while being fished the most intensively (539 fisherman-days per mile - Table 7). Therefore, it might be concluded that the Channel Area was one of the most productive sections of the river. The rate of catch of 0.32 fish per hour on Madison Reservoir was only slightly better than the average of 0.30 fish per hour on Hebgen Reservoir.

It was noted in 1952 in the Upper Section that many fishermen returned fish to the water. The return of 5 to 10 fish per party was not unusual. One man who caught 19 fish, 4 said to weight over 2 pounds, in 14 hours of fishing returned all to the water. Of 477 parties interviewed between late July and the end of the season, 88 returned some or all of their fish to the water. This practice was noted but not recorded in the other two years. Due to lack of comparable data from the other two years, fish returned to the water in 1952 were not considered in calculating the rate of catch. Had the fish been retained and included in the calculations, the average rate might have been materially higher.

FIGURE 7 - COMPARISON OF RATE OF CATCH AND 8:00 AM TEMPERATURES, MADISON RIVER, 1950, 1951 AND 1952.



Water temperatures were recorded at 8:00 a.m. each day certain check areas were under observation. Figure 7 was prepared for three areas, one in each year, to show the general correlation between these morning water temperatures 4/ and rate of catch. There was a similarity of correlation in the three seasons. In general, there was an increase in the rate of catch at the beginning of the season as morning water temperatures increased until these reached about 50° F. From then until mid-August when maximum temperatures of between 60° and 70° were reached, the average rate of catch decreased slightly. With the subsequent decline in water temperatures the rate of catch again increased. Generally a higher rate was reached in the fall than in the spring, even though fall water temperatures approached those at the start of the fishing season.

The average time individuals spent fishing the river varied from 3.2 to 5.8 hours. The maximum time was spent in Upper Bear Trap Canyon, the most difficult area to reach. The minimum time was spent in Madison Canyon which was adjacent to the highway and received a high percentage of nonresident use. Local or resident fishermen spent, on the average, 0.5 hours more per fishing day than the nonresident. In the Lower Section, where 94 percent of the fishermen were residents, the number of hours varied from 4.5 to 5.8 hours. In the Middle Section with 78 percent resident fishermen, the average time ranged from 3.8 to 5.0 hours. In the Upper Section where 55 percent of the fishermen were nonresidents, the average time was between 3.2 and 3.8 hours. Considerable variation was found in the average daily time spent fishing in Madison and Hebgen Reservoirs. Five and one-half hours for Madison Reservoir as compared to 3.2 hours for Hebgen Reservoir again points up the lesser time spent by nonresidents (94 percent residents on Madison and 55 percent nonresidents on Hebgen).

The time of day that fishing was done presented an interesting pattern and seems to be correlated with residence of the fishermen. Most of the fishing activity occurred in the early evening in the Lower and Middle Sections where the largest percentage of fishermen were residents. On the other hand, greatest fishing activity was in mid-afternoon in the Upper Section. It was noted that nonresidents seldom fished in the early morning or evening; thus, with 55 percent of the pressure in the upper Section by nonresidents, the pattern of use shifted to midafternoon.

Rainbow and brown trout (Figure 8) were taken throughout the river and in both reservoirs more frequently than any other fish. Eighty-seven and one-half percent of all fish taken were of these 2 species. Whitefish (6.6 percent) and suckers (4.5 percent) were the

---

4/ Late afternoon temperatures were generally 10 to 15° higher than morning temperatures.

Fig. 8. A representative catch of one brown trout and two rainbow trout taken from Bear Trap Canyon in 1950. (Photo by W. T. Miller).

next most frequently taken fish. The remaining species (1.4 percent) included brook trout, cutthroat trout, grayling, and Utah chub (Table 4). Except in the Lower Bear Trap Canyon Area where brown trout occurred most frequently in the creel, more rainbows were taken than any other fish. Generally, browns became less prevalent in creels as one progressed upstream. The Varney Area and Hebgen Reservoir were exceptions to this general tendency. Whitefish entered the catch in greatest abundance in the Lower Bear Trap Canyon and McAtee Areas, constituting 23.8 and 26.2 percent of the total recorded catch for these areas. Suckers constituted 11 percent of the recorded catch in Madison Reservoir. Utah chubs were most prevalent in Hebgen Reservoir where 21.3 percent of the catch was of this species. Grayling entered the catch in the greatest numbers in the Channel Area, but even there this species was of minor importance since they constituted only 1.4 percent of the total recorded catch.

There was a general decline in the size and weight of trout from the mouth of the river to Hebgen Dam; on the other hand, whitefish were generally larger in the upper reaches of the river (Table 5). The same general rule applied to the size and weight of these species in Madison Reservoir as compared to the upstream Hebgen Reservoir.

Fishermen appeared to be about equally divided as to their use of natural baits or artificial lures. Natural baits, including angleworms, grubs, and insects (salmon flies and grasshoppers), were used most commonly in the early part of the season. Artificial flies, dare-devils, and spinners were used most frequently during the latter part of the season. A few fishermen used "minnows" (Cottus sp.) which were excellent for catching large fish. Fishermen using minnows frequently caught trout weighing four or more pounds. Trolling with lures, bait, or a combination of both was the most popular means of fishing in the reservoirs. The popularity of the spinning rod noticeably increased each year.

The largest recorded trout was a rainbow 32 inches long, weighing 5 pounds (dressed). The largest recorded brown trout was 24 inches long and weighed 5 pounds. Trout over 24 inches in length were uncommon and less than 25 fish of 24 or more inches in length were recorded in any one year. Legal limits of 15 trout (or 10 pounds and 1 trout) per person were seldom recorded, however this does not mean that limits were not taken by many individuals.

The percent of men, women, and children (under 16 years of age) using the river was: men, 83; women, 12; and children, 5. There was some variation from these percentages in certain areas; for instance, in the more inaccessible Upper Bear Trap Canyon and Channel Areas, the percentage of men was 87 and 87, respectively, while the percentage of women was only 8 and 9 percent respectively; and in the McAtee Area 16 percent of the fishermen were women as against 79 percent men. The percent of men, women, and children using the two reservoirs were: Madison Reservoir--70 percent men, 22 percent women, and 8 percent children; and Hebgen Reservoir--71 percent men, 23 percent women, and 6 percent children.

Nonresident fishermen were represented to the extent of 6 percent in the Lower Section, 22 percent in the Middle Section, and 55 percent in the Upper Section. Many of the nonresidents undoubtedly were attracted to the Upper Section by its natural beauty (Frontispiece) and proximity to Yellowstone National Park, as well as by the river's reputation as a good fishing stream. Fishermen from 40 states, Washington, D. C., Alaska, Canada, and South America were contacted during the study. Arkansas was the only state west of the Mississippi River not represented.

Table 8. Number and Percent of Fishing Parties from Various Radii Distances (Airline Miles), Madison River, Montana, 1950, 1951, and 1952

| Section | Radius in Miles | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 - 25 | | 26 - 50 | | 51 - 100 | | 101 - 200 | | 201 - 300 | | 301 and Over | | Total | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Lower | 668 | 23.1 | 1,421 | 49.1 | 323 | 11.1 | 278 | 9.6 | 56 | 1.9 | 151 | 5.2 | 2,897 | 100.0 |
| Middle | 225 | 19.1 | 35 | 3.0 | 343 | 29.1 | 284 | 24.1 | 29 | 2.5 | 264 | 22.4 | 1,180 | 100.0 |
| Upper | 84 | 5.8 | 31 | 2.1 | 82 | 5.7 | 355 | 24.5 | 261 | 18.0 | 635 | 43.9 | 1,448 | 100.0 |
| Total | 977 | 17.7 | 1,487 | 26.9 | 748 | 13.5 | 917 | 16.6 | 346 | 6.3 | 1,050 | 19.0 | 5,525 | 100.0 |

The radius of influence of the three sections of the river was determined on the basis of the number of parties coming from within a radius of 25, 50, 100, 200, and 300 or more miles. It will be noted from Table 8 that the radius of influence became progressively greater from the Lower to the Upper Section of the river. Over 80 percent (83.3) of the fishing pressure came from within 100 miles in 1950 as compared to over 85 (86.4) percent from over 100 miles in 1952. The Middle Section was in an intermediate position. The circumstances in regard to usage from within a 100-mile radius were to be expected since the upper reaches of the Madison lie in a thinly-populated mountainous area; it is only in the lower reaches that it gets into an area of significant population. The fact that the fishing pressure from over 300 miles radius increased progressively from the Lower to the Upper Section, (Lower Section, 5.2 percent; Middle Section, 22.4 percent; and Upper Section, 43.9 percent) tends to emphasize the aforementioned thought that nonresidents were attracted by the progressively more natural beauty of the upper sections of the river and proximity to Yellowstone National Park.

Many fishermen, especially nonresidents, came to the Madison for extensive periods, making use of the many available camp sites or cabin camps. Some of these people indicated that they made annual fishing and vacation trips to the Madison. This attests, at least in part, to the esteem in which many fishermen hold the Madison. Although the majority of these people stayed in the area less than 2 weeks, some stayed as long as 30 to 60 days.

## FISHERMAN-EXPENDITURE STUDY

Data on fishermen's expenditures were obtained during all three years of the Madison River study, on the basis that fishermen expenditures are a partial reflection of the value of the fishery. In the following analysis, the total and component parts of the average daily expenditure per person have been determined for the three sections of the river (reservoirs included) studied in the respective years of the investigation, and in turn applied to the respective estimates of the total number of fisherman-days and yield. Total expenditures have been derived for each reservoir and each section of the river and summarized for the Madison River as a whole.

### Transportation Expenditures

The average round-trip mileage and transportation expenditure for the three sections are shown in Table 9.

Table 9. Round-trip Mileage and Transportation Expenditure per Person per Day, Madison River, Montana, 1950, 1951, and 1952

| Year | Section | Number in Sample | Round-trip Mileage per Person per Day | Expenditure per Person per Day at 7¢ per Mile |
|---|---|---|---|---|
| 1950 | Lower 1/ | 7,482 | 50.7 | $ 3.55 |
| 1951 | Middle | 2,957 | 42.0 | 2.94 |
| 1952 | Upper 2/ | 3,023 | 97.6 | 6.83 |

1/ Madison Reservoir included.
2/ Hebgen Reservoir included.

Nonresidents ordinarily travel greater distances to make use of a fishery than do residents; therefore, since the percentage of nonresidents fishing in the Lower Section (6 percent) was considerably smaller than those fishing in the Middle Section (22 percent), it might be expected that the average round-trip mileage for the Lower Section would be the smaller of the two. The fact that the reverse situation occurred (Table 9) can be explained largely on the basis of two factors: (1) limited human population in the immediate vicinity of the Lower Section and (2) the indirect routes necessary to reach various parts of the area (see map). The Lower Section was readily accessible at only two major points, at Ennis Lake and by the Bozeman-Norris Road, necessitating round-about travel to reach the area. The population in the immediate vicinity of most of the area was generally quite low. For instance, no one lived adjacent to 15 of the 33 miles of river in the Lower Section. Considering these two conditions, it becomes evident that, on the average, even local users would have to travel quite some distance to reach the river. On the other hand, the population in the immediate vicinity of the river in the Middle Section was higher; therefore, the shorter distances traveled by the relatively fewer local users would offset to a certain extent the longer distances traveled by the larger proportion of nonresidents. The road system, which was generally much better in the Middle Section than the Lower Section, also alleviated the need for extensive travel for local users to get to the river. The large round-trip mileage for the Upper Section can be attributed to the high percentage of nonresidents, low rural population, and distance from a center of population.

## Trip Expenditures

The average trip expenditure per person per day for each section of river is shown in Table 10.

Differences in the cost of services or supplies as related to trip expenditures during the three years of study were so small as

to be insignificant; therefore, the differences in trip expenditures were due to other circumstances. Nonresident usage probably is the most important factor. Since nonresidents ordinarily have greater expenses for food and lodging than local people, the increase in trip expenditures from the Lower to the Upper Section was to be expected.

Table 10. Average Expenditure per Person per Day for Trip Items, Madison River, Montana, 1950, 1951, and 1952

| Year | Section | Number in Sample | Trip Expenditure per Person per Day | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Food | Lodging | Bait | Fees | Miscellaneous | Boat Rental | Other Rental | Total |
| 1950 | Lower | 7,506 | $0.68 | $0.40 | $0.05 | $0.01 | $0.54 | $0.12 | $0.05 | $1.85 |
| 1951 | Middle | 2,488 | 1.25 | 0.80 | 0.01 | 0.03 | 0.41 | 0.01 | 0.00 | 2.51 |
| 1952 | Upper | 2,670 | 1.71 | 1.36 | 0.04 | 0.01 | 0.60 | 0.02 | 1/ | 3.75 |

1/ Less than 1 cent.

Annual and Investment Expenditures

Because of difficulties inherent in obtaining annual and investment expenditure information in the field, no attempt was made to gather these data during the present study; however, information on these two expenditures is available from a study conducted in three Montana counties (Fish and Wildlife Service 1951b). Data from this study are believed applicable to the Madison River fishery, since the type of equipment used by the fishermen (cold-water fishermen) was quite similar and the license fee was the same 5/. The county surveys revealed considerable variation in the per-person per-day expenditure for combined investment and annual items between cold-water fishermen in Valley and Roosevelt Counties ($2.97) and Yellowstone County ($3.65), but because of the better sample in the Yellowstone County survey 6/ it is believed that the expenditure of these fishermen more closely

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

5/ Annual expenses of Yellowstone County fishermen were based on a resident fee of $3.00 for a combination small-game and fishing license. The majority of the nonresidents using the Madison fishery purchased a season license at $10. Therefore, annual expenses of the average fisherman using the Madison probably is somewhat higher than for the Yellowstone County fishermen, but the amount of the increase is indeterminable and has been disregarded.

6/ Eighty-two percent of 187 license holders interviewed in Yellowstone County could be classified as cold-water fishermen, as against only 18 percent of 170 license holders interviewed in Valley and Roosevelt Counties.

approximates that of the Madison River fishermen. Accordingly, data from Yellowstone County, modified as indicated below, has been applied in completing the analysis for the Madison River.

It should be recognized that data gathered in the Yellowstone County survey refer to the per-person, per-day expenditure of the average license holder, and not to the expenditure of the average fisherman in the field with whom this report is concerned. The difference between the expenditures of the average license holder and the average fisherman in the field exists because the more avid fisherman, due to the frequency of his trips (and greater use of his equipment), has a lower per-day expenditure and has a greater chance of being interviewed in the field than the occasional angler. Expenditures for the average fisherman, then are expenditures for the average license holder, weighted according to the number of times he went fishing.

Modification of the Yellowstone County data in accordance with the above principle, was accomplished as follows: the average season expenditure for combined annual and investment items ($33.40) was divided by the average number of days spent cold-water fishing (12.5) to determine the cost per day of $2.50 (rounded from $2.68). The proportionate portion of the $2.50 chargeable to annual expenditures would be $0.45 while the portion chargeable to investment expenditures would be $2.05.

Total Expenditures

Summation of the average transportation and trip expenditures for each year, plus the $2.50 assumed for annual and investment expenditures results in a total daily expenditure per person as shown in Table 11.

Table 11. Average Daily Expenditure per Person, Madison River, 1950, 1951, and 1952

| Year | Section | Average Daily Expenditure per Person for | | | |
|---|---|---|---|---|---|
| | | Transportation | Trip Items | Annual and Investment Items | Total |
| 1950 | Lower | $ 3.55 | $ 1.85 | $ 2.50 | $ 7.90 |
| 1951 | Middle | 2.94 | 2.51 | 2.50 | 7.95 |
| 1952 | Upper | 6.83 | 3.75 | 2.50 | 13.08 |

Application of the daily expenditure per person derived for each section of the river to the estimated number of fisherman-days, and yield in pounds of fish for the respective sections permit the derivation of total expenditures, expenditure per mile of stream or surface

acre of reservoir, and the cost per pound of fish, all of which are indicative of the relative worth of the various areas involved. On this basis, fisherman expenditures on the Madison River approximate $412,500 annually. Total expenditures per mile of stream or surface acre of reservoir and per pound of fish are shown for the three sections of stream and the two reservoirs in Table 12.

## DISCUSSION

Comparisons of the various units of the Madison River fishery on the basis of total fishing pressure and yield already have been made in this report and considerable variation shown (Tables 6 and 7). Variations in the physical and biological nature of the different areas lessen the significance of any comparison on this basis.

Fishing success, as measured by the rate of catch, offers a somewhat better means for comparison in judging the relative merits of the various areas. While rates of catch also may be affected by many of the same factors that cause variation in the total fisherman-days and yield, these values afford the best common denominator for comparison from the point of view of the angler.

There was considerable variation between the different units of the study even on the basis of fishing success. Fishing success on the two reservoirs was quite similar--Madison Reservoir at 0.32 fish per hour and Hebgen Reservoir at 0.30 fish per hour; but that on the river varied from 0.37 to 0.82. Some of this variation may be attributed to the greater or lesser degree of utilization (Table 7) but since some of the more productive areas were fished quite heavily, the higher rates in some sections must be attributed to other factors. It might be assumed that biological and physical conditions in certain sections were such as to cause those sections to be more productive. Unfortunately the study was not conducted in such manner as to provide data from which definite conclusions could be drawn.

A number of creel census studies have been made of other streams and reservoirs throughout the Rocky Mountain region; and, although for a variety of reasons, few of these other bodies of water are comparable to the Madison River or Hebgen and Madison Reservoirs, comparisons on the basis of rate of catch provide a general idea of the relative quality of the fishing in the Madison River. A comparison of rates of catch for streams is shown in Table 13 and for reservoirs in Table 14.

In comparing the rates of catch of the streams in the study area with those for other streams (Table 13) it will be noted that, with respect to numbers of fish caught per hour, the rates for all three sections of the Madison River are in the lower half of the other studies

Table 12. Fisherman Expenditures, Madison River, Montana, 1950, 1951, and 1952

| Item | 1950 | | 1951 | 1952 | | Total |
|---|---|---|---|---|---|---|
| | Lower Section | | Middle Section | Upper Section | | |
| | River | Madison Reservoir | River | River | Hebgen Reservoir | |
| Number of fisherman-days | 8,107 | 7,972 | 7,307 | 7,246 | 10,140 | 40,772 |
| Expenditure per-person per-day 1/ | $ 7.90 | $ 7.90 | $ 7.95 | $ 13.08 | $ 13.08 | 2/ $ 10.12 |
| Total expenditure | $ 64,045.30 | $ 62,978.80 | $ 58,090.65 | $ 94,777.68 | $ 132,631.20 | $ 412,523.63 |
| Surface acres, or miles of stream | 33 | 3,800 | 34 | 31 | 13,400 | 17,200 98 |
| Expenditure per acre, or mile of stream | $ 1,940.77 | $ 16.15 | $ 1,708.55 | $ 3,057.34 | $ 9.90 | 2/ $ 11.37 2/ $ 2,213.40 |
| Yield in pounds of fish | 19,352 | 18,144 | 17,139 | 11,894 | 16,153 | 82,682 |
| Cost per pound of fish | $ 3.31 | $ 3.47 | $ 3.39 | $ 7.97 | $ 8.21 | 2/ $ 4.99 |

1/ It is recognized that there were differences in the average transportation expenditure (round-trip mileage) and trip expenditures made by fishermen using the Lower River and Madison Reservoir in 1950 and the Upper River and Hebgen Reservoir in 1952. Tests of the data indicated that these differences were relatively small and they were disregarded for purposes of this report, even though, because of the method of calculation (number of fisherman-days x expenditure per person per day), small differences in the daily expenditure per person could make a material difference in the total estimated expenditure per area. A limited test of basic data pertaining to the Lower Section indicated that the difference in mileage per person per day would be less than one mile. On the other hand, expenditures for boat rentals were mostly applicable to Madison Reservoir and, if applied to Madison Reservoir only, would approximate 25 cents as against the 12 cents shown in Table 10; thus, the average expenditure per person per day on the river could be as little as $7.78 while that for Madison Reservoir could be as much as $8.03. Separation of data for the Upper Section, as completely as the data would permit (there was some overlap in usage of the river and the reservoir in the same day), indicated that the average round-trip mileage was about 97 ($6.79) for the river and 100 ($7.00) for Hebgen as against the weighted average figure of 97.6 miles ($6.83) used (Table 9). As in the case of the Lower Section, boat rentals were chargeable to reservoir fishermen, and if reservoir fishermen were so charged, boat rentals applicable to Hebgen fishermen would amount to about 12 cents. Considering these conditions, the average daily expenditure per Upper-Section fisherman could have been as little as $13.06 for river fishermen and as high as $13.18 for reservoir fishermen.

2/ Weighted averaged derived from basic figures in this column.

Table 13. Comparison of Hourly Rates of Catch in Numbers and Pounds of Fish for the Madison River Fishery with Other Western Trout Streams

| Stream | Location | Year | Number of Fish per Hour | Number of Pounds per Hour | Reference |
|---|---|---|---|---|---|
| Little Salmon | Idaho | 1952 | 1.31 | - | Murphy 1953 |
| North Platte River, Upper Section | Wyoming | 1951 | 1.13 | 0.79 | Fish and Wildlife Service 1953c |
| Clackmas River | Oregon | 1940 | 1.10 | - | Nielson 1941 |
| Colorado River | Colorado | 1948 | 1.09 | 0.32 | Hess, Seaman, and Barrows 1949 |
| W. Gallatin River, Upper Section | Montana | 1949 | 1.07 | 0.42 | Fish and Wildlife Service 1951a |
| Gunnison River | Colorado | 1949 | 1.02 | 0.45 | Hess, Seaman, and Barrows 1949 |
| Gunnison River | Colorado | 1948 | 0.96 | 0.40 | Hess, Seaman, and Barrows 1949 |
| Republican River | Colorado | 1946 | 0.96 | 1/0.36 | Hess and Klein 1946 |
| Colorado River | Colorado | 1949 | 0.93 | - | Hess, Seaman, and Barrows 1949 |
| Taylor River | Colorado | 1946 | 0.89 | 1/0.36 | Hess and Klein 1946 |
| Colorado River | Colorado | 1948 | 0.79 | 0.32 | Hess, Seaman, and Barrows 1949 |
| Beaver Creek (North Fork Sun River) | Montana | 1951 | 0.76 | 0.18 | Fish and Wildlife Service 1953d |
| Big Thompson River | Colorado | 1946 | 0.75 | 1/0.18 | Hess and Klein 1946 |
| Cache La Poudre | Colorado | 1946 | 0.72 | 1/0.20 | Hess and Klein 1946 |
| North Fork Sun River, Lower River | Montana | 1951 | 0.72 | 0.30 | Fish and Wildlife Service 1953d |
| MADISON RIVER, MIDDLE SECTION | Montana | 1951 | 0.62 | 0.54 | - - - - |
| Gunnison River | Colorado | 1946 | 0.62 | 1/0.29 | Hess and Klein 1946 |
| W. Gallatin River, Middle Section | Montana | 1949 | 0.57 | 0.36 | Fish and Wildlife Service 1951a |
| Pishkun Canal (North Fork Sun River) | Montana | 1951 | 0.56 | 0.19 | Fish and Wildlife Service 1953d |
| MADISON RIVER, UPPER SECTION | Montana | 1952 | 0.55 | 0.47 | - - - - |
| Rio Grande | Colorado | 1946 | 0.53 | 1/0.22 | Hess and Klein 1946 |
| W. Gallatin River, Middle Section | Montana | 1950 | 0.51 | 0.35 | Fish and Wildlife Service 1951a |
| Arkansas River | Colorado | 1946 | 0.50 | 1/0.30 | Hess and Klein 1946 |
| North Fork Sun River (Middle River) | Montana | 1951 | 0.46 | 0.13 | Fish and Wildlife Service 1953d |
| North Fork (North Fork Sun River) | Montana | 1951 | 0.45 | 0.33 | Fish and Wildlife Service 1953d |
| South Fork (South Fork Sun River) | Montana | 1951 | 0.45 | 0.33 | Fish and Wildlife Service 1953d |
| MADISON RIVER, LOWER SECTION | Montana | 1950 | 0.53 | 0.44 | - - - - |
| Colorado River | Colorado | 1948 | 0.32 | - | Hess, Seaman, and Barrows, 1949 |
| Yellowstone River | Wyoming | 1951 | 0.24 | - | Moore, Cope, and Beckwith 1952 |

1/ Computed. when only the average length was indicated the assumption was made that fish from this area had the same length-weight relationship as fish taken from the Madison.

Table 14. Comparison of Hourly Rates of Catch in Numbers of Fish and Pounds of Fish for the Madison River Fishery with Other Western Cold-water Lakes and Reservoirs

| Lake or Reservoir | Location | Year | Surface Acres | Number of Fish per Hour | Pounds of Fish per Hour | Reference |
|---|---|---|---|---|---|---|
| Fish Lake | Utah | 1940 | 2,500 | 2.00 | — | Wright 1943 |
| Fish Lake | Utah | 1941 | 2,500 | 1.80 | — | Wright 1943 |
| Fish Lake | Utah | 1942 | 2,500 | 1.50 | — | Wright 1943 |
| Taylor Reservoir | Colorado | 1949 | 2,033 | 1.44 | 0.14 | Hess, Seaman, and Barrow 1949 |
| Vallecito Reservoir | Colorado | 1949 | 2,720 | 0.66 | 0.20 | Hess, Seaman, and Barrow 1949 |
| Vallecito Reservoir | Colorado | 1948 | 2,720 | 0.55 | 0.26 | Hess, Seaman, and Barrow 1949 |
| Taylor Reservoir | Colorado | 1947 | 2,033 | 0.55 | 0.30 | Hess, Seaman, and Barrow 1949 |
| Fish Lake | Utah | 1947 | 2,500 | 0.54 | — | Anonymous 1948 |
| Vallecito Reservoir | Colorado | 1945 | 2,720 | 0.46 | 1/0.23 | Hess and Klein 1946 |
| Gibson Reservoir | Montana | 1951 | 1,360 | 0.38 | 0.29 | Fish and Wildlife Service 1953d |
| HEBGEN RESERVOIR | Montana | 1952 | 13,400 | 0.37 | 0.30 | - - - - |
| MADISON RESERVOIR | Montana | 1950 | 3,800 | 0.32 | 0.32 | - - - - |
| Vallecito Reservoir | Colorado | 1946 | 2,720 | 0.32 | 1/0.16 | Hess and Klein 1946 |
| Green Mountain Reservoir | Colorado | 1945 | 2,100 | 0.30 | 1/0.30 | Hess and Klein 1946 |
| Green Mountain Reservoir | Colorado | 1946 | 2,100 | 0.25 | 1/0.19 | Hess and Klein 1946 |
| Green Mountain Reservoir | Colorado | 1949 | 2,100 | 0.22 | 0.14 | Hess, Seaman, and Barrow 1949 |
| Willow Creek Reservoir | Montana | 1951 | 1,400 | 0.18 | 0.25 | Fish and Wildlife Service 1953d |
| Strawberry Reservoir | Utah | 1948 | 8,200 | 0.15 | — | Anonymous 1949 |
| Green Mountain Reservoir | Colorado | 1947 | 2,100 | 0.14 | 0.11 | Hess, Seaman, and Barrow 1949 |
| Alcova Reservoir | Wyoming | 1951 | 2,500 | 0.09 | 0.11 | Fish and Wildlife Service 1952 |
| Pishkun Reservoir | Montana | 1951 | 1,500 | 0.07 | 0.12 | Fish and Wildlife Service 1953d |
| Pathfinder Reservoir | Wyoming | 1951 | 22,600 | 0.05 | 0.14 | Fish and Wildlife Service 1952 |

1/ See footnote 1, Table 13.

listed and therefore can be considered as slightly below average in this respect. On the other hand, the Madison River was surpassed by only two other areas in fishing success in terms of pounds of fish per hour and in this respect is considerably above average.

When comparing rates of catch on lakes and reservoirs in the study area with those of other lakes and reservoirs in the Rocky Mountain region (Table 14), the reservoirs in the study area fall midway in the list of reservoirs in respect to numbers of fish per hour and therefore may be considered average. Although two of the listed reservoirs have rates of catch in pounds of fish equal to Hebgen Reservoir (0.30 pounds per hour) the two reservoirs are not surpassed in this respect by a single other one of the other bodies of water listed.

Comparisons of fishing pressure and yield of the Madison River with a variety of other trout streams would be desirable. Unfortunately, the only streams on which comparable studies have been made are the West Gallatin and North Fork Sun Rivers in Montana. Fishing and yield determined for a 28-mile stretch of the West Gallatin in 1950 was 460 fisherman-days and 580 fish or 400 pounds of fish per mile (Fish and Wildlife Service 1951a); that for 8 miles of the North Fork Sun River, which could be considered to have access comparable to the Madison and West Gallatin, was 253 fisherman-days and 476 fish or 134 pounds of fish per mile in 1951 (Fish and Wildlife Service 1953d).

Considering the 98 miles of the Madison River covered in this study, pressure and yield per mile was 231 fisherman-days and 535 fish or 494 pounds of fish. Although these values are not particularly outstanding when compared to those of the foregoing streams, greater potentialities are suggested for the river as a whole when comparisons are made with certain check areas (Table 7). For example, in the 5-mile Channel Area, where pressure was 539 fisherman-days per mile, yield was 1,772 fish weighing 1,487 pounds. In the 11-mile Upper Bear Trap Canyon Area the yield was 1,214 fish weighing 1,208 pounds, with a pressure of 452 fisherman-days per mile. In spite of the fact that the biological and physical conditions might have been such that certain portions of the stream were more productive than others, it still remains that were all portions equally accessible, (i.e., from the point of view of both road network and posting against trespass) the Madison River could stand considerable more pressure and continue to yield high returns to the fishermen.

Results of expenditure studies similar to those described in this report have been analyzed for a number of other cold-water fisheries. Results of these studies are shown comparatively in Tables 15 and 16. There is considerable variation in the expenditure items listed in Table 15. As has been shown in the cited references and

Table 15. Comparison of the Average Expenditure per Person Per Day, per Pound of Fish, and per Surface Acre or Mile of Stream for the Madison River Fishery with Other Cold-water Fisheries in the Missouri Basin

| Fishery | State | Year | Average Expenditure | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | | Per Person per Day | Per Pound 1/ | Per Surface Acre | Per Mile | |
| Pathfinder Reservoir | Wyoming | 1951 | $ 7.22 | $ 3.94( 8.27) | $ 2.51 | $ | Fish and Wildlife Service,1952 |
| Alcova Reservoir | Wyoming | 1951 | 5.79 | 5.39(10.76) | 11.00 | | Do. |
| Fremont Canyon | Wyoming | 1951 | 6.49 | 4.55( 9.22) | | 2,190.00 | Do. |
| North Fork Sun River, Lower Section | Montana | 1951 | 5.91 | 5.05 | | 346.54 | Fish and Wildlife Service,1953d |
| North Fork Sun River, Middle Section | Montana | 1951 | 5.91 | 11.13 | | 1,492.28 | Do. |
| North Fork Sun River, Upper Section | Montana | 1951 | 10.70 | 8.59 | | 142.95 | Do. |
| Pishkun Canal | Montana | 1951 | 5.91 | 12.16 | | 88.16 | Do. |
| Willow Creek Reservoir | Montana | 1951 | 5.91 | 4.42 | 0.85 | | Do. |
| Pishkun Reservoir | Montana | 1951 | 5.91 | 12.26 | 6.01 | | Do. |
| Split Rock Lake | Montana | 1951 | 5.91 | 4.12 | 25.41 | | Do. |
| Tunnel Lake | Montana | 1951 | 5.91 | 9.96 | 99.29 | | Do. |
| Diversion Reservoir | Montana | 1951 | 5.91 | 7.25 | 131.58 | | Do. |
| Gibson Reservoir | Montana | 1951 | 6.57 | 4.07 | 4.32 | | Do. |
| Wood Lake | Montana | 1951 | 6.14 | 11.88 | 118.20 | | Do. |
| West Gallatin River, Upper Section | Montana | 1949-50 | 4.48 | 4.71 | | 1,220.00 | Fish and Wildlife Service,1953b |
| West Gallatin River, Middle Section | Montana | 1949-50 | 4.48 | 5.02 | | 1,940.00 | Do. |
| North Platte River | Wyoming | 1952 | 15.45 | 8.10 | | 15,613.00 | Fish and Wildlife Service,1953c |
| Deerfield Reservoir | South Dakota | 1949-50 | 5.20 | 3.64 | 89.12 | | Fish and Wildlife Service,1953a |
| MADISON RIVER, LOWER SECTION | Montana | 1950 | 7.90 | 3.31 | | 1,940.77 | - - - - |
| MADISON RIVER, MIDDLE SECTION | Montana | 1951 | 7.95 | 3.39 | | 1,708.55 | - - - - |
| MADISON RIVER, UPPER SECTION | Montana | 1952 | 13.08 | 7.97 | | 3,057.34 | - - - - |
| MADISON RESERVOIR | Montana | 1950 | 7.90 | 3.47 | 16.57 | | - - - - |
| HEBGEN RESERVOIR | Montana | 1952 | 13.08 | 8.21 | 9.90 | | - - - - |

1/ Parenthetical figures for trout only, others for all fish caught.



Table 16. Comparison of the Component Parts of the Average Total Expenditure per Person per Day for the Madison River Fishery with Other Cold-water Fisheries in the Missouri River Basin

| Fishery 1/ | Annual 2/ | Investment 2/ | Trip | Transportation | Total | Round-trip Mileage per Person per Day |
|---|---|---|---|---|---|---|
| Pathfinder Reservoir | $ 0.45 | $ 2.05 | $ 1.33 | $ 3.39 | $ 7.22 | 48 |
| Alcova Reservoir | 0.45 | 2.05 | 0.80 | 2.49 | 5.79 | 36 |
| Fremont Canyon | 0.45 | 2.05 | 0.59 | 3.40 | 6.49 | 49 |
| North Fork Sun River, Middle and Lower Sections | 0.45 | 2.05 | 0.70 | 2.71 | 5.91 | 39 |
| North Fork Sun River, Upper Section | 0.45 | 2.05 | 5.33 | 2.87 | 10.70 | 41 |
| Gibson Reservoir | 0.45 | 2.05 | 1.89 | 2.18 | 6.57 | 31 |
| Wood Lake | 0.45 | 2.05 | 0.43 | 3.21 | 6.14 | 46 |
| West Gallatin River | 0.39 | 2.11 | 0.31 | 1.67 | 4.48 | 14 |
| North Platte River | 0.48 | 2.20 | 8.43 | 4.34 | 15.45 | 62 |
| Deerfield Reservoir | 0.09 | 1.20 | 1.31 | 2.60 | 5.20 | 37 |
| MADISON RIVER, LOWER SECTION | 0.45 | 2.05 | 1.85 | 3.55 | 7.90 | 51 |
| MADISON RIVER, MIDDLE SECTION | 0.45 | 2.05 | 2.51 | 2.94 | 7.95 | 42 |
| MADISON RIVER, UPPER SECTION | 0.45 | 2.05 | 3.75 | 6.83 | 13.08 | 98 |
| MADISON RESERVOIR | 0.45 | 2.05 | 1.85 | 3.55 | 7.90 | 51 |
| HEBGEN RESERVOIR | 0.45 | 2.05 | 3.75 | 6.83 | 13.08 | 98 |

1/ See Table 15 for references.
2/ Except for the West Gallatin River and Deerfield Reservoir where data were obtained in the field this expenditure was applied from results obtained from a survey of Yellowstone County license holders (Fish and Wildlife Service, 1951b).

preceding sections of this report, the average expenditure per person per day is dependent upon a number of factors. Of these factors, the miles traveled is the most important as it in turn affects trip expenditures (Table 16). The average expenditure per pound of fish is affected not only by the total expenditure per person per day, but also by the rate of catch (both in numbers and pounds of fish per hour). Expenditures per surface area of water or mile of stream are indirectly affected by the same factors as those affecting expenditures per person or per pound of fish.

Although the Madison River may not be particularly outstanding as regards the return to the fisherman in fish per hour of effort, it is highly productive of fairly large fish and probably can support a considerable greater amount of fishing without affecting its productivity. It has a widespread reputation as a good fishing stream, is relatively easy to fish, lies in an area of prevailing fair weather during the fishing season and in an area of natural scenic beauty, and contributes much to the local economy; therefore, in view of increasing demands for fishing and the increasing number of streams that are being modified through water development, every consideration should be given to maintaining this stream in a productive natural state.

## SUMMARY


1. Fishing pressure and yield of 119 miles of the Madison River in Montana, including two onstream reservoirs - Madison and Hebgen - was determined over the three-year period 1950 to 1952. The river was divided into three more or less equal sections, one of which was studied in each of the three years. For the purpose of this report, it has been assumed that there was no difference in the relative use and yield of the three sections from year to year.

2. Estimated annual fishing and yield from the fishery as a whole was 40,772 fisherman-days and 80,459 fish weighing 92,682 pounds. Separated into the component fisheries, i.e., stream (98 river-miles) or reservoir (Madison, 3,800 acres, and Hebgen, 13,200 acres), the annual fishing and yield for the stream fishery was 22,660 fisherman-days and 52,424 fish weighing 48,385 pounds and that for the reservoir fishery was 18,112 fisherman-days and 28,035 fish weighing 34,297 pounds.

3. Species of fish taken by anglers from the fishery as a whole were: rainbow trout, 65.4 percent; brown trout, 22.1 percent; brook trout, 0.2 percent; cutthroat trout, 0.2 percent; grayling, 0.5 percent; whitefish, 6.6 percent; suckers, 4.5 percent; and Utah chub, 0.6 percent.

4. Rates of catch in fish per hour and pounds per hour of effort varied from 0.43 to 0.82 and 0.38 to 0.67, respectively, for

various areas on the stream and from 0.30 to 0.32 and 0.37 to 0.39, respectively, on the two reservoirs.

5. The percent of resident fishermen varied from 94 in the Lower Section to 45 in the Upper Section. The Upper Section was closest to Yellowstone National Park.

6. Results of the fisherman-expenditure study indicated an average per-day expenditure of: Lower Section and Madison Reservoir, $7.90; Middle Section, $7.95; and Upper Section and Hebgen Reservoir, $13.08. The average expenditure per pound of fish for each section of river and reservoir was: Lower Section River, $3.31; Madison Reservoir, $3.47; Middle Section, $3.39; Upper Section, $7.97; and Hebgen Reservoir, $8.21. The total average annual expenditure by fisherman was estimated to be $412,500.

7. Comparisons were made of the Madison River fishery with other Rocky Mountain streams and reservoirs and of fisherman expenditure data for the Madison River fishery with those for other cold-water fisheries.

## Literature Cited


Anonymous

1948. Fishery investigation at Fish Lake, Utah, fishing season 1947. Utah St. Ag. Coll., Coop. Wild. Res. Unit, 2 pp. (Mimeo.)

1949. A summer study of the fishing of Strawberry Reservoir, Wasatch County, Utah, 1948. Utah St. Ag. Coll., Coop. Wild. Res. Unit, Quarterly Activity Report, Jan., Feb., March 1949.

Fish and Wildlife Service

1951a A two-year fishery investigation of the West Gallatin River, Montana, 1949-1950. U.S.D.I., Fish and Wild. Ser., Mo. River Basin Studies, 42 pp. (Mimeo.)

1951b Annual and investment expenditures of Montana sportsmen, 1949. U.S.D.I., Fish and Wild. Ser., Mo. River Basin Studies, 29 pp. (Mimeo.)

1952. A one-year creel census and fisherman expenditure study, Alcova and Pathfinder Reservoirs, North Platte River, Wyoming. U.S.D.I., Fish and Wild. Ser., Mo. River Basin Studies, 43 pp. (Mimeo.)

1953a Fisherman-expenditure study, Deerfield Reservoir, South Dakota, 1949-1950. U.S.D.I. Fish and Wild. Ser., Mo. River Basin Studies, 10 pp. (Mimeo.)

1953b Fisherman-expenditure study, West Gallatin River, Montana, 1949-1950. U.S.D.I., Fish and Wild. Ser., Mo. River Basin Studies, 11 pp. (Mimeo.)

1953c Fishery investigation of a portion of the North Platte River, Wyoming, 1951. U.S.D.I. Fish and Wild. Ser., Mo. River Basin Studies, 16 pp. (Mimeo.)

1953d One-year creel census and fisherman-expenditure study, North Fork Sun River and associated fisheries, Montana, 1951. U.S.D.I., Fish and Wild. Ser., Mo. River Basin Studies, 53 pp. (Mimeo.--also to be published in 1954 in Special Scientific Report: Fisheries No. 120.)

Hays, Raymond A.

1950. Utah chub in Hebgen Lake. Mont. Fish and Game Dept., Bear Facts and Fish Tales, March 1950.

Hess, R. H. and W. D. Klein
1946. 1946 creel census report. Colo. Game and Fish Dept., 19 pp. (Mimeo.)

Hess, R. H., W. R. Seaman, and P. T. Barrows
1949. 1949 creel census report. Colo. Game and Fish Dept., 29 pp. (Mimeo.)

Moore, H. L., O. E. Cope, and R. E. Beckwith
1952. Yellowstone Lake trout creel census, 1950-1951. U.S.D.I., Fish and Wild. Ser., Spec. Sci. Rept.-Fisheries 81, 41 pp.

Murphy, L. W.
1953. Random creel census of the Little Salmon River, Ida. Fish and Game Dept., Quart. Prog. Rept. for Invest. Proj., Federal Aid in Fish and Wild. Rest., Proj. F7-R-1, 10 pp. (Mimeo.)

Neilson, R. S.
1941. Creel data on Clackamas River, Oregon. Prog. Fish-Cult. 54:37-38.

Rounsefell, George A.
1946. Fish production in lakes as a guide in estimating production in proposed reservoirs. Copeia 1:29-39.

Wright, Stillman
1943. Some unregarded factors in creel census studies. Trans. 8th No. Am. Wild. Conf.:387-392.

## APPENDIX A

Water Analyses, Madison River, Montana, 1951[1/]

(Analysis expressed in parts per million)

| Location | McAtee Bridge | Ennis |
|---|---|---|
| Sample No. | M-4430 | M-4431 |
| Date Collected | 7/31/51 | 8/1/51 |
| pH | 7.7 | 8.0 |
| Specific conductance Micromhos at 25° C. | 227 | 235 |
| Silica ($SiO_2$) | 28 | 30 |
| Iron (Fe) | 0.02 | .02 |
| Calcium (Ca) | 17 | 18 |
| Magnesium (Mg) | 3.5 | 3.9 |
| Sodium (Na) ) | | |
| Potassium (K) ) | 24 | 24 |
| Carbonate ($CO_3$) | 0 | 0 |
| Bicarbonate ($HCO_3$) | 97 | 100 |
| Sulfate ($SO_4$) | 3.0 | 5.0 |
| Chloride (Cl) | 15 | 15 |
| Fluroide (F) | 2.0 | 2.0 |
| Nitrate ($NO_3$) | 0.8 | 0.7 |
| Boron (B) | -- | -- |
| Dissolved Solids Sum-ppm | 162 | 166 |
| Hardness as $CaCO_3$ | | |
| Total | 57 | 61 |
| Noncarbonate | 0 | 0 |
| Percent Sodium | 48 | 46 |

1/ Analysis made by U.S. Geological Survey, Lincoln, Nebraska